JPRS-USP-90-004
5 OCTOBER 1990

JPRS Report

Science & Technology

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Cosmonaut Crews End Training, Ready for Aug Mission

PM1307140190 Moscow Television Service in Russian 1700 GMT 12 Jul 90

[From the "Vremya" newscast]

[Text] [Announcer] Presentation of the seventh main expedition which has completed preflight training was held at Zvezdnyy Gorodok today.

[Correspondent] Those who think that decorations are bestowed on cosmonauts automatically should take a look at this. This is old footage dating back to 1983. This film has never been shown on the "Vremya" newscast; its very preservation is a miracle. There is no mention of this launch in official sources. Vladimir Titov and Gennadiy Strekalov were inside the spacecraft at the time. [video shows cosmonauts strapped in spacecraft which is subsequently completely engulfed in flames before it finally lifts off] They have both spent time in space.

[Video shows, from right to left, Gennadiy Strekalov, flight engineer, main crew, being interviewed; Gennadiy Manakov, flight commander, main crew; Musa Manarov, flight engineer, backup crew; Viktor Afanasyev, flight commander, backup crew; correspondent P. Orlov]

[Correspondent] Now Gennadiy Strekalov is to go up into space again as flight engineer of the main crew.

[Strekalov] What we want is no hitches, we want everything to go according to plan.

[Correspondent] Does this ever happen?

[Strekalov] Oh, yes.

[Correspondent] I mean, does it ever happen that everything goes swimmingly? [Strekalov hesitates, the others grin]

[Strekalov] Well not swimmingly, not as a rule. There are always some kind of deviations. But that is what we are trained for although it would be better if they could be avoided.

[Correspondent] This is Musa Manarov, flight engineer of the backup crew, who has spent 365 days working on the "Mir" space station with Vladimir Titov. [old footage showing him alighting from craft after space flight] Now he is off into space again.

[Musa Manarov, facing camera] It must be frankly admitted that there are experiments which clearly produce nothing. Not many, it is true, but it happens. I would like ill-conceived methodology and poorly prepared apparatus to be avoided. It's just a waste of time, and that is a pity.

[Correspondent] Flight commanders are responsible for everything that happens on the station during the flight. The flight commanders of both crews are novices who have not been in space before. This is Gennadiy Manakov, flight commander, main crew. And the backup crew is headed by Viktor Afanasyev. [video shows closeups of them at work]. They have undergone the full training course and have worked at the assembly units at Baykonur and Zvezdnyy Gorodok near Moscow. They are responsible for the program which is to be carried out on the station and for the continuation of the experiments initiated by the current expedition.

And so it is back to the cosmodrome 19 July. This time one of the crews will be launched into space at the beginning of August.

Report on 17 Jul EVA to Repair Soyuz TM-9

PM1907092990 Moscow Television Service in Russian 1430 GMT 17 Jul 90

[Report by Petr Orlov from the "Vremya" newscast]

[Text] [Announcer] We will now go over to the Flight Control Center. Petr Orlov reports:

[Correspondent] Literally a few minutes ago Flight Engineer Aleksandr Balandin, in accordance with accepted practice, was the first to leave the "Mir" station and is now working in open space.

We will now show you very briefly the route which Commander Anatoliy Solovyev and Flight Engineer Aleksandr Balandin have to take today.

Here on one of the screens at the Flight Control Center you can see the very top of the module [video shows diagram]. The cosmonauts must descend to the transfer section and move on to the next module. From there they will begin to work on the thermal insulation of the "Soyuz TM-9" craft which has become detached.

This is an untrodden, untried route. The wires of the television camera will not reach. This is why we have no pictures today. Only late tonight will we receive pictures taken by the cosmonauts. This is why there is tension everywhere today. It is because the cosmonauts themselves will have to decide what is to be done with the thermal insulation.

Here you can see what they will have to do. This is precisely the type of thermal insulation that has become detached, exactly the same. It is not a question of the thermal insulation of the spacecraft but this kind of cover. [video shows thermal insulation material] It will either have to be replaced in the fasteners—no one knows why it has become detached—or it will have to be rolled back like an army blanket—which is how they describe it here—and tied back with string. This is the reserve option.

Regarding equipment, the Flight Control Center is entirely satisfied that all is well. The thermal insulation does not worry them. All the instruments are ready. Here

they are. They look pretty daunting. [video shows correspondent picking up a pair of shears] This is what our cosmonauts have to work with in open space.

The main problem is that no one knows what state the explosive bolts [piropatrony] are in, which serve to separate the landing module on descent. This is where they are located, precisely here. [correspondent points to diagram] This spot was covered by the thermal insulation. No one knows what it looks like there. The cosmonauts will be the first to know. They will report to ground control, and then further decisions will be made. This will happen in approximately 90 minutes when the cosmonauts reach their workplace. We will keep you up to date in subsequent newscasts on the progress of work carried out by Anatoliy Solovyev and Aleksandr Balandin in open space.

Cosmonauts Unable To Close 'Kvant-2' Hatch

PM2007082390 Moscow Television Service in Russian 1700 GMT 18 Jul 90

[Report by Petr Orlov from the "Vremya" newscast]

[Text] [Announcer] Here is a report from the Flight Control Center.

[Correspondent] As is often the case, the most unexpected thing happened when a successful end to the operation seemed within sight.

You will recall that yesterday during the "Vremya" newscast it was promised that the cosmonauts would be back in the station by 1000 hours. This was not to be.

Having fastened the thermal insulation, that is, having performed their task, Anatoliy Solovyev and Alexandr Balandin turned homeward, pressed for time, it is true. They tied down the tools and set off. But they must have slightly lost their way. Now they are already joking about it.

[Cosmonaut; video shows cosmonauts in spacecraft] There are many ropes and handrails, what we need is street signs.

[Correspondent] These are pictures taken late last night. When people at the Flight Control Center gather around one panel, it means that something is happening. And it was. The cosmonauts entered the station but were unable to close the hatch. Meanwhile the space suit oxygen was running out. Were the crew's lives in danger? Yes, they were. Instead of the scheduled six hours they had spent seven hours in the space suits. It was impossible to take further risks. They had to move on to another compartment, a hermetically sealed compartment. Nothing like this has ever happened before. The station's exit hatch is still open and in one of the compartments of the "Mir" space station there is space vacuum now. However the station, like a ship, is divided by partitions behind which it is possible to hide. Today, it no longer seems so terrible.

[Voice from Flight Control Center] How do you feel about the open door? Isn't there a chair floating about?

[Cosmonaut; video shows cosmonauts inside spacecraft] The seat is safely fastened. Yes the garage door is open, but no one is likely to walk in.

[Correspondent] Today, following an analysis, the main danger seems to lie elsewhere. The tools left in space may hamper further work. Judging by appearances, the time frame of the expedition will not be altered. But it seems that for the time being the station's main docking unit can only perform undocking. If this is really the case, it seems that another space walk by this crew will be necessary to improve the situation. This question is now being discussed at the Flight Control Center and a decision seems likely within the next few days.

Second EVA Scheduled for 26 Jul

LD1907163390 Moscow Domestic Service in Russian 1400 GMT 19 Jul 90

[Report by Leonid Lazarevich]

[Summary] The "Mir" spacecraft crew members are to make a second spacewalk on 26 July. The air lock compartment of the equipment module remained unsealed when the cosmonauts were unable to shut the exit hatch after their spacewalk two days ago. A special working group has been studying the problem almost constantly since then.

"There is no final conclusion on what happened. The situation is being analyzed as before. But the working group has made a decision that on the 26th the crew will evidently go out into open space. They will again attempt to open and shut the door and will then go through, take away the ladder on which they were working before and which they left behind, and return."

I have just spoken with the crew. "I can't tell you that they were very happy, but they are full of optimism."

Cosmonauts Prepare for Second Space Walk

PM2507132190 Moscow PRAVDA in Russian 25 Jul 90 Second Edition p 1

[TASS Report: "Preparations for Walk in Open Space"]

[Text] Flight Control Center, 24 Jul—The crew of the sixth main expedition of the Mir scientific research complex is continuing its flight.

Within the framework of the program of astrophysical experiments, two series of surveys of the celestial sphere have been carried out using the "Glazar" ultraviolet telescope. Measurements of X-ray, gamma, and neutron radiation of nonterrestrial origin are conducted regularly with the help of the "Buket" telescope and the "Granat" spectrometer installed on the "Kristall" module.

Experiments in the onboard "Svet" and "Svetoblok-M" hothouses are continuing under the space biology program in order to study the development of higher plants under orbital flight conditions. Radishes, lettuces, and wheat seedlings have been chosen as the objects of research. Another biological experiment—"Gel"—was begun Monday.

Throughout most of today Anatoliy Solovyev and Aleksandr Balandin will be engaged in preparing their space suits and equipment for a walk in open space scheduled for 26 July. The cosmonauts have to perform a number of dismantling jobs on the outer surface of the complex and to close the outer hatch of the "Kvant-2" module's airlock, which could not be fully closed at the time of the 17 July egress.

According to the results of medical screening, the state of health of the commander and the flight engineer is good.

EVA Authorized for Nine-Hour Duration

LD2507211190 Moscow Television Service in Russian 1700 GMT 25 Jul 90

[From the "Vremya" newscast; report by correspondent Sergey Slipchenko]

[Text] The public is following the development of events aboard the Mir manned space station with rapt attention and concern. The emergency that has arisen there, connected with the cosmonauts' egress into space, was discussed today by the competent commission.

Well, obviously, the station has been operating for many years, and, clearly, there is some limit of fatigue. So what has happened in orbit? Our correspondent reports.

[Slipchenko] Over the past few days, we have received many phone calls at our television studios and at the Mayak radio station. Our viewers and listeners are asking: What really is happening on board the Mir space station? What's going on in space? Tomorrow will see the latest extravehicular activity by cosmonauts Anatoliy Solovyev and Aleksandr Balandin. What will they be doing?

At Flight Control Center today there was a meeting of state commission and a technical council of the main specialists, at which the priorities of today's work in space were assigned. [video shows meeting in progress in large room; then switches to a diagram of the Mir space station; Slipchenko points to various parts of the diagram during the rest of the report]

The main task tomorrow is, nevertheless, not to close the hatch; the main task is for the cosmonauts to lower themselves once again to this point, [Slipchenko indicates the spot on the diagram], to this star-shaped docking assembly on the Mir space station, and here to free the handrails that they set up in order to move along the station, along the ship, then repairing the vacuum shield heat insulation. These handrails may prevent the space ship—it's indicated here in the diagram—from undocking. But the main thing is that, if these handrails swing about freely, unfixed, they may prevent the docking of a future ship and a future expedition. The cosmonauts will then have to return up, along the resupply module, to this hatch [Slipchenko indicates which one with his pen] and try to close the hatch.

How are the cosmonauts living at the moment? Colored in red [on the diagram] is the compartment of the station that is no longer hermetically sealed. The compartment can now be said to contain space. But between the red and the green colors [two adjacent compartments: the red one with the open hatch and the green one to which it is attached] there is also a bulkhead, a hatch. It is shut. Throughout the rest of the station, the cosmonauts are working normally and are continuing to carry out their program. So, if it proves impossible to close the hatch, the station can function indefinitely in this position. Many people ask what will happen if the next hatch also malfunctions. Well, if the next hatch malfunctions, the cosmonauts will surrender the next section to space. And this will go on until the ship itself is reached. [video shows meeting in progress again]

At the same commission today, all services started their readiness, and a decision in principle was adopted. The specialists extend the time of the cosmonauts' work to the upper limit—to nine hours in the spacesuits.

Progress of Second EVA Reported

PM2907141590 Moscow Television Service in Russian 1430 GMT 26 Jul 90

[Report by Sergey Slipchenko from the "Vremya" newscast]

[Text] [Announcer] Allow me to remind you, comrades, that cosmonauts Anatoliy Solovyev and Aleksandr Balandin have been working in space for the past two hours, since 1515 hours. This work is continuing and our special correspondent at the flight control center will tell you about it. We switch over.

[Slipchenko] You see scenes from the flight control center where communications with the Mir space station have been virtually continuous today. The point is that the cosmonauts are now far beyond the range of the television cameras. They have descended to the spot where the module is docked with the Mir orbital complex. They are now removing the handholds—this, as we reported in yesterday's "Vremya" newscast, is a priority task—they are either removing these handholds or fastening them down firmly so that they are not in the way during the undocking of the spaceship or during the docking of the next expedition.

Well, as the saying goes, better to see once for yourself than be told a hundred times. At the very beginning of the space walk, two hours ago, the cosmonauts took a television camera to show the hatch which refuses to close. When the cosmonauts climbed out to show the

hatch they discovered the faulty feature. I do not want to go into technical details. Experts are now working on it. But it is true that one of the structural features of the hatch has been damaged. It is either a design fault, or it has occurred through mishandling. Time will tell. But the main thing is that the problem has been identified. When the cosmonauts return—you can see a diagram of their long journey on your screens [video shows diagram of space station], they are working down below where the small figure is on the diagram—when they return they will try once again to close the hatch.

The specialists at the flight control center who are in charge of this operation have just gathered us here and told us that even if the hatch remains open this will not affect the further course of the space expedition. All the foreign press reports are unfounded. The space program continues and it will continue for many years to come as planned. That is, all the international crews will work on board the Mir station. I hand back to the studio to Igor Fesunenko, but we will keep you briefed on the progress of work in space.

Report on Hatch Problem

PM3007100790 Moscow Television Service in Russian 1700 GMT 26 Jul 90

[Report by Sergey Slipchenko from the "Vremya" newscast]

[Text] [Announcer] New work was conducted in outer space today starting at 0315 Moscow time. How did it end? We should be getting a report on this from our correspondent at the mission control center. I will now ask my producer whether the mission control center is on the line. Give us the mission control center please.

[Slipchenko] You are looking at the mission control center. We had been saying that at this time there would be a report from the cosmonauts aboard the "Mir" station. But the hall is empty; everyone's left. The cosmonauts spent 3 hours 31 minutes in outer space. Well here are the results of today's work. The ladders which the cosmonauts left beside the hatch during their previous work have been removed and secured in places where they will not impede docking; that was the first task of the walk. The second task was the hatch which had caused so much concern; it has been closed. The situation was analyzed back on the ground and it was established that it would be possible, with great difficulty, to close the hatch. And indeed the cosmonauts made a very great effort and closed the hatch. [video shows giant-screen shots of interior of spacecraft] Now you can see a recording here on one of the mission control center's TV screens. When the cosmonauts first inspected the hatch this is what they saw. Unfortunately the camera is shaking about and we can't see the hatch, but it showed specialists all the details of this component. I want to show it to you now. [shows photograph] This photograph has been taken off the video, and this reddish spot on the picture is the very place where pressure was applied—the catch [uklyuchina] on the Mir station. So if you look closely, this is the Mir station and this is the hatch. And it was this [word indistinct] that stopped the hatch closing. The cosmonauts made an effort to push on this catch and the hatch closed. The cosmonauts are now working under normal conditions. The airtightness of the compartment will be verified within 24 hours. Only then will the decision be made to open the compartment for normal activity or not. Now I'd just like to say a few words about what has been written in the Western press—the space program has been called into question. I won't give my opinions, I will just report the facts. Today we were told here that 506 of the 520 experiments planned for this mission have been carried out. Some 21 million square kilometers of the Earth's surface has been photographed at very high resolution—five to seven meters. These are unique and invaluable photographs for determining the ecological situation not only in our country but in many other countries too. Foreign news agencies and specialists are interested in these photographs. Twenty-three capsules with unique crystals will be sent back to Earth by the mission. Well, I can say that protein crystals are being grown, and Western specialists—Americans in particular—estimate that one such crystal is worth $1 million. Many such crystals will be grown on board. The next mission will send back 90 kg of cargo. A special Progress spaceship with a descent capsule will be launched for the next mission. Those are the results of this mission. That closes our report and I hand you back to Igor Fesunenko. The space program is continuing in conditions that are safe for the cosmonauts.

Solovyov, Balandin Mark 170 Days in Orbit

LD3107125690 Moscow TASS in English 1224 GMT 31 Jul 90

[Text] Moscow July 31 TASS—TASS correspondent reports from the Mission Control Center:

Anatoliy Solovyov and Aleksandr Balandin have been working for 170 days in a near-earth orbit on board the "Mir" space station.

In accordance with the program of space material studies, the crew completed another smelt using the unit "zone-03".

Experiments were conducted using "Kristallizator" equipment designed by Czechoslovak and Soviet specialists. This equipment is meant for fundamental research into crystallisation of various materials and alloys in weightlessness.

Today the crew is to conduct geophysical research. There are plans for visual observations and photography of tracts of forest in southern Siberia that were affected during forest fires in 1989.

The experiments could help develop methods of spotting and assessing the state of sections with anomalous development of vegetation.

Yesterday Solovyov and Balandin underwent thorough checks of the cardiovascular system during training in the pneumovacuum suit Chibis. The results of medical survey indicate that both cosmonauts are in good health.

Preparations for the launching of "Soyuz TM-10" manned spaceship are being concluded at Baykonur Cosmodrome. The ship will be blasted off at 13 hours 23 minutes Moscow time on August 1.

Soyuz TM-10 Launched

LD0108124190 Moscow TASS in English 1227 GMT 1 Aug 90

[Text] Moscow August 1 TASS—The Soviet Union today launched a spaceship with two cosmonauts for a link-up with the orbiting Mir (Peace) platform to relieve the resident crew of Anatoliy Solovyev and Aleksandr Balandin who have been working in space for the past six months.

The replacement team of Gennadiy Manakov and Gennadiy Strekalov blasted off from Baykonur spaceport in the Soyuz TM-10 spaceship at 13:32 Moscow time and, mission control officials told TASS, are in buoyant spirits and feeling well.

The officials said the takeoff went without a hitch, precisely on schedule.

It was watched by numerous foreign reporters, among them Japanese correspondents including TBS Television's Rioko Kikuchi and Toiehiro Akiyama, one of whom is going to take part in a Soviet-Japanese space mission to Mir slated for next December.

The two correspondents have been preparing for the flight at the Cosmonaut Training Center outside Moscow. The Japanese cosmonaut is expected to return to earth with Manakov and Strekalov in Soyuz TM-10 after a program of joint research and scientific experiments with Soviet colleagues.

In addition to the Japanese there are British and Austrian aspiring spacemen currently undergoing training at the center, dubbed recently an international space academy.

Soyuz TM-10 Maneuvers for Link-up

LD0208105990 Moscow TASS in English 1051 GMT 2 Aug 90

[Text] Moscow August 2 TASS—TASS correspondent reporting from the Mission Control Center:

Gennadiy Manakov and Gennadiy Strekalov, who are heading for the Mir orbital station in the Soyuz TM-10 spaceship, on Wednesday checked the serviceability of the ship's onboard systems and the air-tightness of its compartments. They maneuvred the spaceship for Friday's link-up with the orbital station.

The parameters of the Soyuz TM-10 spaceship's orbit are as follows after correction:

—maximum distance from the Earth's surface - 385 kilometers;
—minimum distance from the Earth's surface - 314 kilometers;
—period of revolution - 91.3 minutes;
—orbit inclination - 51.6 degrees.

Anatoliy Solovyev and Aleksandr Balandin are preparing to greet the new crew and conducting scientific research today.

Under the program of geophysical experiments, the cosmonauts will carry out a series of visual observations and take pictures of separate sections of the earth's surface along the station's flight path.

Experiments aim to "assess the ecological state of water bodies and forest tracts in the southern areas of the European part of the Soviet Union and Central Asian republics."

The cosmonauts are planning to conduct the Rezonans experiment to define the dynamic characteristics of the orbital station which is a complex space system.

Cosmonauts Manakov, Strekalov, Solovyev, and Balandin are in good health according to the results of the radio talks.

The Soyuz TM-10 spaceship is calculated to dock with the Mir station at 15:47 on Friday, August 3.

TV Report on Launch of Soyuz TM-10

PM0308114590 Moscow Television Service in Russian 1430 GMT 1 Aug 90

[Report by S. Slipchenko, G. Vishneva, A. Gerasimov, and V. Pankratov from the "Vremya" newscast]

[Text] [Announcer] In accordance with the space exploration program, the Soyuz TM-10 spacecraft was launched today, 1 August 1990, at 1332 hours Moscow time. It is piloted by a crew comprised of Spacecraft Commander Gennadiy Mikhaylovich Manakov and Flight Engineer USSR Pilot-Cosmonaut Gennadiy Mikhaylovich Strekalov, twice Hero of the Soviet Union. Here is a reportage by our special correspondents:

[Correspondent] The cosmonauts' day started as usual. Then, having donned the space suits, the cosmonauts met with representatives of the state commission, the chief designer, the leadership of the cosmodrome, and the guests who have arrived at Baykonur. Today there are particularly many guests, mainly Japanese.

The cosmonauts report to the chairman of the state commission.

[Manakov] Comrade chairman of the state commission, the crew of the Soyuz TM-10 spacecraft is ready for the mission.

[Colonel General Ivanov] I wish you a successful mission and safe return home. Have a good journey!

[Manakov] Thank you.

[Strekalov] Thank you.

[Correspondent] During the preparations for this launch Vladimir Leontyevich Ivanov was appointed chairman of the state commission. Officially he was the deputy chairman, but Kerim Aliyevich Kerimov is sick, so on this occasion the decisions were made and the state commission was headed by Colonel General Ivanov. The cosmonauts are leaving for the launch complex. [video shows bus leaving, followed by close-up of launch complex, cosmonauts alighting from bus, final farewells]

This launch has a special meaning for those who are familiar with our space program. In 1983 Gennadiy Strekalov walked toward the launch vehicle just like today but that flight was destined not to take place.

The cosmonauts have climbed up on a small ramp in front of the elevator and you will be able to see, if not hear, Gennadiy Strekalov sending personal greetings to Aleksey Aleksandrovich Shumilin. General Shumilin is a veteran staffer of the cosmodrome. I have talked about him several times. [video shows Slipchenko exchanging a few words with Shumilin] He is the very man who managed, in a split second before a launch vehicle which had caught fire on the launch pad with Gennadiy Strekalov aboard, [words indistinct] to issue the command to abort the mission. And Gennadiy Strekalov and Vladimir Titov, who were in the spacecraft, were saved.

There are very many people on the spectators' platform today. Representatives of major Japanese companies and also of American Express are at the cosmodrome, as well as the director of [words indistinct due to background noise], the company which is preparing to send a cosmonaut to the Mir station at the end of December this year.

There is much talk about commerce in space, and specialists have very rightly warned against a dilettantish attitude toward this matter and against thinking that we can quickly earn large sums of money from cosmonautics to solve all kind of problems. Another view is that with this money we can obtain output produced in space which will help us grow rich.

So what is the value of the knowledge acquired by Soviet scientists and designers in the course of space exploration?

Well, this knowledge is currently attracting some of the biggest and most prominent financiers and businessmen. This is what interests them.

[Video shows cosmonauts in craft ready for blastoff, shots of the mission control room, and the launch pad as the props move away and the Soyuz TM-10 blasts off]

[Newscaster] Let's wish the cosmonauts successful work in space!

Soyuz TM-10 Docks With Mir Station

LD0308122390 Moscow TASS in English 1218 GMT 3 Aug 90

[Text] Moscow August 3 TASS—The Soviet spacecraft Soyuz TM-10 docked with the Mir orbital complex at 15:46 Moscow time [1146 GMT] today.

Cosmonauts Gennadiy Manakov and Gennadiy Strekalov, who blasted off aboard Soyuz TM-10 on August 1, will replace the crew of the sixth main expedition, Anatoliy Solovyov and Aleksandr Balandin, who spent nearly six months on board Mir.

New Crew To Repair Damaged Hatch

LD0408135290 Moscow World Service in English 1110 GMT 4 Aug 90

[Excerpts] On 4 August four Soviet cosmonauts staying on board the orbital space station Mir began their first joint working day. [passage omitted]

Manakov and Strekalov are also expected to do more important work to repair one of the hatches of the Mir station. That will have to be done outside the station. Variants of the repair work have already been rehearsed on Earth. The head of the Soviet cosmonauts' training center, Vladimir Shatalov, is convinced that one walk in open space will be quite enough to fully complete the repairs of the hatch. As has been reported by Ground Control Center, all the four cosmonauts feel well and all systems on board the space station are functioning properly. Stay informed with Radio Moscow about the more interesting stages of the new Soviet space mission.

Japanese Cosmonaut Trainees View 'Soyuz TM-10' Docking

LD0308153590 Moscow TASS in English 1458 GMT 3 Aug 90

[By TASS correspondent Rena Kuznetsova]

[Text] Moscow August 3 TASS—The Soyuz TM-10 spaceship docked with the Mir complex today at 15:46, Moscow time. Two crews are now working in space.

Cosmonauts Gennadiy Manakov and Gennadiy Strekalov who will man the Mir complex during the seventh main space mission, will replace Anatoliy Solovyov and Aleksandr Balandin who have been working at the complex for nearly six months.

According to experts, the docking was made neatly and precisely on time. Numerous foreign correspondents who gathered at the Mission Control Center watched the

docking. They included Rioko Kikuchi and Toyehiro Akiyama, staff members of the Japanese TBS TV company.

One of them will participate in a joint Soviet-Japanese space mission scheduled for this December. They are preparing for the flight at the Cosmonaut Training Center in Moscow region.

It is planned that one of them will return to the earth aboard the Soyuz TM-10 together with Manakov and Strekalov after the end of the mission. The Japanese journalist will conduct scientific studies and carry out experiments together with the Soviet counterparts.

Along with the Japanese journalists, British and Austrian future cosmonauts are training at the Center.

TASS learnt at the Mission Control Center that the seventh main space mission will last 132 days. It is planned during this time to carry out 250 experiments for various sectors of the national economy and to make at least two space walkouts.

One of the crew's main tasks is to grow super-pure crystals for the radioelectronic industry at the Kristall module.

Joint Work of Crews Aboard 'Mir'

LD0608195490 Moscow TASS in English 1848 GMT 6 Aug 90

[By TASS correspondent Rena Kuznetsova]

[Text] Moscow August 6 TASS—Two Soviet space crews have been working in orbit for the fourth day. Anatoliy Solovyev and Aleksandr Balandin, who spent almost six months in orbit, are turning over their duties to the crew of the seventh main expedition, Gennadiy Manakov and Gennadiy Strekalov.

The four cosmonauts will work together until August 9. Then Solovev and Balandin are expected to return to earth at 11.35 Moscow time. They have carried out an extensive program of physical, technological, astrophysical, natural studies and medico-biological research, and experiments for the benefit of various branches of the national economy. They had two space walks.

The crews set about a regular melt on the Zona-03 installation under the program of the study of materials in space. High-purity semi-conductors with improved characteristics are expected to be obtained as a result of this experiment for the radio-electronic industry.

Today the cosmonauts televised a reportage from orbit to the Mission Control Center. All those present were gratified by the excellent crop and size of garden radish grown in the "space conservatory" in zero gravity or, to be more exact, on the Svet installation co-designed by Soviet and Bulgarian specialists. Lettuce is also ripe. These vegetables are expected to be used for research purposes so far, but time is not far off when cosmonauts would be able to taste fresh vegetables grown in space, a spokesman at the Mission Control Center told TASS.

Cosmonauts Continue Transition Operations Aboard 'Mir'

LD0708140990 Moscow TASS in English 1354 GMT 7 Aug 90

[Text] Moscow August 7 TASS—Four Soviet cosmonauts have spent their fifth day on board the Mir space complex.

Anatoliy Solovyev and Aleksandr Balandin checked the operation of the movement control system of the Soyuz TM-9 spaceship that will carry them back to the earth.

They will also perform training sessions in the Chibis pneumatic-vacuum suit and on the moving platform.

Gennadiy Manakov and Gennadiy Strekalov continue to inspect the lay-out and receive some additional instructions concerning the operation of numerous equipment on the complex.

They will prepare to operate a technological unit of the Kristall module today.

Under the program of space materials science, the cosmonauts made another smelting on the Zona-03 installation. They produced a super-pure monocrystal of germanium.

Biological experiments are also under way. The cosmonauts feed and video-tape quails ferried to the complex and monitor the microclimate at greenhouses with higher plants.

The flight is running smoothly. The cosmonauts feel well.

'Kvant-2' Hatch Problem Result of Crew Error

907Q0138A Moscow IZVESTIYA in Russian 28 Jul 90 Morning Edition p 1

[Article by S. Leskov: "Not in Outer Space by Choice"]

[Text] On 26 July, Anatoliy Solovyev and Aleksandr Balandin performed a second space walk. The crew had to finish what it did not succeed in doing during the previous walk—most importantly, to close the exit hatch of the "Kvant-2" module.

The cosmonauts spent three and a half hours outside the orbital station, a little more than was planned according to the schedule, and they executed the assigned tasks completely. Everything is fine, but why is it so disturbing?

There is no argument for on that day the "springs" [R. "Rodniki", crew callsign] were working very well. Two ladders—straight and curved—were left on the surface of

the orbital complex after the previous walk. In principle, these ladders could have become snagged on some station rigging and prevented vehicle undocking and docking. The crew moved along the familiar route, unhooked the ladders, and carefully attached them to the side of the "Kristall" module.

But these operations, frankly speaking, are not complicated. It was more difficult with the hatch. They examined it immediately, even before the approach to the ladders. A closeup was shown to earth with the aid of a television camera. The eye was struck by a deformity in one of the two hinges on which the exit hatch swings out. They were unable to cope with the defect immediately despite all their efforts. There is nothing in the airlock compartment for the cosmonauts to rest on—the hatch was sprung, tossing people like a trampoline.

While they were walking after the ladders, designers in the Mission Control Center racked their brains. They outlined a whole program of clever metalwork manipulations with the dislocated hinge. Solovyev and Balandin followed this advice—the hatch began to work more freely and finally closed itself. A check on hatch sealing was reassuring: Not even the slightest gap to outer space remained.

But what was the cause of the breakdown? Incidentally, this hatch was used twice by the previous crew without any incidents. I. Vostrikov, deputy general designer of the "Salyut" Design Bureau, where outer space models are made, had no doubts: During the last exit the present crew broke the technological cycle of hatch opening. According to the rules the operation should occur as follows: Open the hatch slightly by one millimeter and, using a manometer, watch carefully while the air from the air lock goes out into space and the pressure drops to zero. Only after this can the hatch be taken off the stop and pushed outward by hand.

But the crew was in a hurry and did not wait until the pressure equalized; it removed the stop—and a stream of air wrenched the hatch forcefully into outer space. This is indirectly indicated by the exclamation "What a bright sun!" which now, besides adding a romantic touch, the designers judge to be technical confirmation of the fact that the crew was unexpectedly blinded by a bright light. The force of the jerk attained 400 kilograms, and although the cosmonauts themselves say they sort of functioned according to established procedures, onboard telemetry data indicates an infraction of the prescribed routine. To be fair, it must be said that Deputy Flight Controller V. Blagov does not hasten with a conclusion: It is not excluded, in his opinion, that there is a defect in plant production. Only further analysis will be able to give the final answer.

But even combat engineers make mistakes. Why was the "Kvant-2" module not provided with a system that insures a person in emergency conditions? Why does the hatch open up into a vacuum, not in the direction of high pressure as it did on all previous space vehicles which ruled out such "bursts." The fact is that a space "motorcycle" is tethered in the air lock and extra space simply could not be found for a metric hatch. Moreover, the hatch was checked a hundred times in ground-based laboratories. But an automatic insurance, in the opinion of I. Vostrikov, would make the vehicle too heavy.

The hatch is closed, but it is not possible to say that it is entirely in order. It can be compared to a window that is nailed up, crisscrossed with boards. Until the hinge is replaced it is hardly likely that they will risk using this hatch, which by the way is the only one in the complex through which the space "motorcycle" can be taken outside. This means that the next crew once again will have to divert its attention to repair operations, and divert it for a long time. "Self-service" on a complex takes up more and more time, and one job engenders another.

A new crew will be launched 1 August. Some results of the sixth long-term expedition on the "Mir" orbital complex can already be summed up. Five hundred and six experiments were performed, the most long-awaited being the switching on of technological stoves and the obtaining of 23 capsules with semiconductor materials. In the television report seen on the "Vremya" program it was announced that these specimens are unique and will go for a price of a million. Have we really obtained a profit from a space flight at last? But for the time being these specimens have not only not been studied and evaluated by anyone, but no one has even held them. To talk today about their unique properties and expected profits is to pass off as real what is desired. It would be more honest to say that the results of ground-based research on outer space materials will facilitate adjustment of the future program of technological work on the complex. I think that we will have to wait a long time more for the repeatedly promised "golden rain" from orbit, especially given such an abundance of irregular situations....

But today everyone has the impression of a successfully completed outcome and well-coordinated crew work. There is an uneasiness, however, probably because a well-known saying was recalled about the amazing Russians who first create difficulties for themselves and then heroically overcome them.

Cosmonauts Land Safely in 'SoyuzTM-9'

LD0908081990 Moscow TASS in English 0811 GMT 9 Aug 90

[Text] Moscow August 9 TASS — Soviet cosmonauts Anatoliy Solovyev and Aleksandr Balandin returned safely to earth today from their almost six-month mission on board the Mir space station.

They touched down at 1135 Moscow time [0735 GMT] near Arkalyk, in Soviet Kazakhstan.

Cosmonauts Gennadiy Manakov and Gennadiy Strekalov, who blasted off to the Mir station on August 1, will stay there under December this year.

New Crew's Schedule Includes Two EVAs

LD0908215690

[Editorial Report] Moscow Domestic Service in Russian at 1308 GMT on 9 August broadcasts a four-minute report on the work of Mir Cosmonauts Gennadiy Manakov and Gennadiy Strekalov. The report begins with special correspondent Vladimir Bezyayev saying that the crew of the seventh main expedition—the Vulcans [Vulkany]—will work on the Mir station until December 1990.

Bezyayev interviews the flight director, Pilot Cosmonaut of the USSR Vladimir Alekseyevich Solovyev, about the work scheduled for the Vulcans: on 15 August the next Progress cargo vessel is to be launched, with docking scheduled on the 17th. This progress will be carrying quite a lot of scientific equipment and a good starting point for our technology, for our cameras, Solovyev says. This progress will be taking up very interesting equipment for the station. "We have thought out how the station's power can be most optimally and sensibly redistributed."

Solovyev says that after undocking from the station, test operations for the returnable capsule will be conducted on this cargo craft because this year it is already being planned that on the next progress cargo vessel, by means of this returnable capsule, some 200 kg of payload will be brought back to earth: these are the smelts, film cassettess, and biotechnology which will be produced. It is planned that the Vulcans will carry out two space walks—one spacewalk devoted to work on the hatch cover, the other one for building up the station's power and for turning it into an industrial works. To this end it will be necessary to install additional solar batteries. Solovyev says that Flight Control Center staff members have begun energetically learning if not the Japanese language then at least the English language because 2 December, the day of the launch of the Japanese cosmonaut, is not far off.

Cosmonauts Solovyev, Balandin Readapting Well

LD1308140990 Moscow TASS in English 1221 GMT 13 Aug 90

[By TASS correspondent Rena Kuznetsova]

[Text] Moscow August 13 TASS—Preliminary medical checks on Anatoliy Solovyev and Aleksandr Balandin, the crew of the sixth main space mission, showed that the cosmonauts were well prepared for their return to earth after a six-month space flight.

Medics note that during the mission the crew fulfilled all medical recommendations to resist the negative effects of weightlessness on the human organism. Regular training enabled them to preserve their fitness under extreme conditions.

According to tradition, the first stage of re-adaptation is taking place at a health building establishment in the cosmonauts' training center near Moscow.

The problem of human adaptation to conditions of weightlessness and after-flight re-adaptation assumes special importance. This problem has emerged as a result of lengthy space missions.

Experience shows that the creation of the Mir space complex and its manning by replaceable crews has justified itself.

Measures developed by specialists in space biology and medicine help cosmonauts successfully overcome the negative influence of weightlessness on people.

Cosmonauts note that hard training helps them preserve their fitness during flights and prepare for the return to earth.

The cosmonauts' conditon is now being closely monitored by medics.

Medical Official Comments on Crews

LD1508063990 Moscow TASS in English 0629 GMT 15 Aug 90

[By TASS correspondent Rena Kuznetsova]

[Text] Moscow August 15 TASS—Man's adaptation to extreme conditions of zero-gravity acquires special urgency today, Soviet Cosmonaut Valeriy Polyakov, deputy director of the Soviet Health Ministry's Institute of Medico-Biological Problems, told TASS. This is primarily connected with the man's long stay in space.

"As a doctor I think that the trend towards creating orbital complexes with replaceable crews, which has recently developed in the Soviet national space program, has proven itself viable at this stage," Polyakov noted.

Doctors are generally happy with the crew of the seventh main expedition to the Soviet orbital complex Mir. The crew blasted off on August 1, 1990. Polyakov stressed that the two men had absolute psychological compatibility which is very important for long expeditions. Mission commander Gennadiy Manakov, who is the space rookie, endures zero-gravity well. "He seems to be a man who has worked in space all his life," Polyakov continued.

Solovyov and Balandin, who returned to earth on August 9, have already gone on walks, Polyakov said. Solovyov had insignificant deviations in the vestibular apparatus but everything quickly returned to normal. Doctors do not regard the deviations as hazardous.

Cosmonauts Continue Research, Crystal Growth Experiments on 'Mir'

LD1408121790 Moscow TASS in English 1106 GMT 14 Aug 90

[By TASS correspondent from the Mission Control Center]

[Text] Moscow August 14 TASS—Soviet cosmonauts Gennadiy Manakov and Gennadiy Strekalov continue the planned research and experiments on board the orbital complex Mir.

In accordance with the program for the study of materials in space, they launched the first experiment on the Zona-2 technological installation. The purpose of the experiment is to obtain experimental batches of germanium and silicon mono-crystals, both in a vacuum and in an argon medium.

Experiments to study the effect of open space on structural materials and elements of radio-electronic equipment are going on. Information on the condition of specimens, which are attached to the outer surface of the Kvant-2 module, is being regularly transmited through telemetric channels to earth and is being processed.

Under the medical check-up plan, the two cosmonauts will today undergo an examination of the blood-circulation system to determine the efficiency of the means to prevent the adverse effect of zero gravity on the human organism.

According to reports from orbit and telemetric date, the flight of the manned orbital complex Mir is proceeding normally.

The two cosmonauts are in good health and are feeling well.

'Progress M-4' Supply Spacecraft Launched 15 Aug

LD1508080690 Moscow TASS in English 0757 GMT 15 Aug 90

[Text] Moscow August 15 TASS—In accordance with the space research program of the Mir complex, the Soviet Union launched an unmanned freight spacecraft, Progress M-4, at 08:01 Moscow time today [0401 GMT].

The vehicle is to bring expendable materials and a variety of supplies to the manned complex Mir.

Progress M-4 was put into orbit with the following parameters:
- maximum distance from the surface of earth 235 km;
- minimum distance from the surface of earth 186 km;
- period of revolution 88.5 minutes;
- inclination 51.6 degrees.

According to telemetric information, the on-board systems of the unmanned cargo spacecraft are functioning normally.

'Progress M-4' Docks With 'Mir' Station

LD1708071390 Moscow TASS in English 0709 GMT 17 Aug 90

[Text] Moscow August 17 TASS—The Progress M-4 tanker-transport vehicle linked up with the Mir orbital complex at 9:26 Moscow time [0526 GMT] today.

The search and docking were controlled by automatic on-board systems. The link-up of the spacecraft with the orbiting station was controlled by the Mission Control Center and Cosmonauts Gennadiy Manakov and Gennadiy Strekalov.

Progress M-4 is attached to the complex at the side of the station's air lock. The re-supply vehicle delivered fuel for the joint propulsion unit, food, water, equipment, and mail.

The on-board systems of the Mir orbital station are operating normally, according to telemetry and the crew's reports. Manakov and Strekalov feel well.

'Progress M-4' Delivers Special Cargo For Soviet-Japanese Flight

LD1708200790 Moscow TASS in English 1938 GMT 17 Aug 90

[By TASS correspondent Rena Kuznetsova]

[Text] Moscow August 17 TASS—From now on the Soviet long-duration orbital complex Mir incorporates the Progress M-4 cargo spacecraft. It was received by the crew of the fourth main expedition—Gennadiy Manakov and Gennadiy Strekalov—who have been working in orbit since August 1.

The cargo spacecraft which docked with the Mir complex has on board fuel for the joint propulsion plant, food, water, equipment, mail, and a special cargo a spokesman at the Mission Control Center told TASS today.

The special cargo is intended [for] an international Soviet-Japanese space flight scheduled for December this year. Together with Soviet cosmonauts the expedition will involve one or two representatives of the Japanese TBS Television Network—Ryoko Kikuchi and Toyohiro Akiyama who are preparing for the flight at the cosmonauts training center near Moscow.

The Progress M-4 is already the fourth cargo spacecraft of new modification launched into space. It differs from its predecessors, of which there were 42, in that it may carry a cargo capsule which is brought back to earth. The present crew are to test the new cargo-carrying spacecraft.

Cosmonauts Proceed With Materials Processing Experiments Aboard 'Mir'

LD2508005490 Moscow TASS in English 1804 GMT 24 Aug 90

[By TASS correspondent Rena Kuznetsova]

[Text] Moscow August 24 TASS—Friday, August 24, can rightly be described as a day of technological experiments aboard the Soviet scientific-research orbital complex Mir. The seventh resident crew of Gennadiy Manakov and Gennadiy Strekalov have been working aboard the station for three weeks.

The cosmonauts today went ahead with smelting on the Krater-B plant, begun on Thursday, under the space material studies program. The smelting will last for 260 hours. As a result, the cosmonauts will obtain, in extreme conditions of the space laboratory, zinc oxide, a semiconducting material of great value for the radio electronic industry.

Also today the cosmonauts got down to growing the monocrystal of gallium arsenide, another semiconductor, on the gallar plant. Gallar is an abbreviation of the words gallium and arsenide. It will also be a long process which will take 240 hours.

Specialists believe that space technology is very promising. They estimated that its application promises an economic effect of 400-800 million rubles a year.

The range of the scientific-research work is being dramatically expanded once the technological module Kristall, which specialists describe as a microplant to produce crystals in zero-gravity, was attached to the Mir orbital complex.

Experimental laboratories of the USSR Ministry of the Electronic Industry already have samples of equipment, specifically a laser picture tube which was developed using the monocrytal cadmium sulphide which was obtained in space and by its technical characteristics has no analogues on earth.

'Kristall' Module Engines To Be Used To Orient 'Mir' Complex

LD2808131890 Moscow TASS in English 1248 GMT 28 Aug 90

[By TASS correspondent at the Mission Control Center]

[Text] Moscow August 28 TASS—Soviet cosmonauts Gennadiy Manakov and Gennadiy Strekalov are continuing the scheduled work to hook the on-board systems of the Kristall module up to the Mir orbiting platform's general loop.

Today the spacemen are to perform operations that will make it possible to use the module's engines to orient and control Mir.

Their research agenda specifies experiments to measure the dimensional and energy characteristics of space radiation and evaluate the influence of raw space on the properties of various structural materials.

According to the results of Monday's [27 August] medical check, Manakov and Strekalov are in good health.

Their mission is continuing as normal.

Cosmonauts Train, Continue Materials Production

LD3008175590 Moscow TASS in English 1741 GMT 30 Aug 90

[By TASS correspondent Rena Kuznetsova]

[Text] Moscow August 30 TASS—Gennadiy Manakov and Gennadiy Strekalov, the crew of the seventh main expedition working on board the Mir space station since August 3, set aside today for training.

Training refreshes skills developed on earth in laboratories and on simulators in the Cosmonauts Training Center near Moscow. The cosmonauts "play through" all possible variants of emergency situations that can occur during a flight.

Both cosmonauts are training every day in the space "mini-stadium" so as to keep in form during the whole flight, which is scheduled to last until December.

Within the framework of the 260 hour space material study program, the cosmonauts also continue work on the Krater-V installation, started on August 23. They are planning to obtain a valuable semiconductor material—zinc oxide.

Another experiment held on the Gallar appliance is intended to grow another semiconductor, gallium arsenide, needed by the radioelectronic industry. The experiment, started on August 24, will last for ten days.

Recoverable Cargo Capsules To Be Used on Future 'Progress' Missions

LD0908145190 Moscow TASS in English 1415 GMT 9 Aug 90

[By TASS correspondent Rena Kuznetsova]

[Text] Moscow August 9 TASS—Soviet cosmonauts Anatoliy Solvoyev and Aleksander Balandin today returned to earth after almost six months on board the Soviet Mir orbital station.

They transferred some 130 kilograms of materials obtained during research and experiments in space.

This was the last time that a return capsule will de-orbit cosmonauts and materials together, TASS was told at the Mission Control Center.

From now on the crew will return separately. Materials will be delivered to earth in the return capsule of a

transport spacecraft. Gennadiy Manakov and Gennadiy Strekalov, who replaced Solovyev and Balandin on board the Mir station, will be the first to test such a capsule.

The sixth expedition, Manakov and Strekalov, are expected to work at the station for 132 days. They are planning to conduct some 250 experiments, including the continuation of work on the Kristall technological module to produce high-purity crystals, and two rounds of extravehicular activities.

U.S. Inventory Control System To Be Used on 'Mir'

LD1208192690 Moscow Television Service in Russian 1700 GMT 12 Aug 90

[From the "Vremya" newscast]

[Excerpt] Soviet space research is being criticized at present for previously being secretive. Its notorious secrecy hinders cooperation between the defense and civilian complexes and the processes of conversion. And joint work between space and defense firms and Western companies can so far be regarded as a rarity, but there is already an example.

[Correspondent S. Slipchenko] For 30 years the developers of Soviet space rocket technology were proud of the fact that in our space technology not a single part, not a single nut, not a single wire that was used was imported, and that everything was done with Soviet materials. It took 30 years to understand that international cooperation is essential in such very complex space rocket systems, and perhaps even in very complex aviation systems. It can now be said that a breach has been made: for the first time automated systems produced in the United States for calculating the freight flow of the Mir orbital station will operate on the Mir station. This equipment will be placed on board the Mir station. Cosmonauts are already working with this equipment and studying it. All the cargoes going on board the Mir station will be marked with these bar codes. These codes can be read in seconds with this reader. It holds around 2,000 signs in its memory for the approximately 2,000 objects that go on board the Mir station. This equipment will precisely and correctly systematize everything going into space orbit. This is the first foreign produced system to operate in our space rocket systems. [passage omitted]

French Cosmonauts Named for 1992 Space Flight

LD0308175990 Moscow TASS in English 1442 GMT 3 Aug 90

[By TASS correspondent Aleksandr Kenykh]

[Text] Paris August 3 TASS—Michel Tognini and Jean-Pierre Haignere are the two French cosmonauts that have been selected for the final training in preparation for the 1992 third Soviet-French space flight codenamed Antares.

A news conference held at the headquarters of the French National Space Research Center (CNES) was dedicated to introducing the two cosmonauts, one of whom will make the space flight together with a Soviet crew.

The biographies of the two cosmonauts have much in common. There is no need to introduce Michel Tognini to Soviet readers for he was the back-up pilot during the second Soviet-French space expedition, whereas Jean-Pierre Haignere will train for the space flight at the Star City for the first time.

The two candidates are test pilots, lieutenant colonels of the French Air Force. Since July 1986 both bear the title of "CNES cosmonaut."

They are almost age-mates, born in 1949 and 1948 respectively.

Haignere is now the head of the department of the CNES manned flights and actively participates in the implementation of the West European space plane project Hermes.

When introducing the two cosmonauts at the news conference, Daniel Sacotte, CNES deputy director-general, emphasised that the two candidates underwent a thorough check-up by both the French side and Soviet specialists.

In several weeks' time, the two will go to the Soviet Union for final training which will continue for 1.5-2 years.

The final choice will be made at the Star City. However, so far a certain preference is being given to Michel Tognini who knows everything well from the previous training, Sacotte said.

Five International Crews To Visit 'Mir' By End of 1992

LD2107135490 Moscow World Service in English 1110 GMT 21 Jul 90

[Excerpt] The new crew is to make a large amount of observations and experiments on the Mir complex. They are to take two spacewalks. At the end of their expedition they will meet in orbit a Soviet-Japanese crew, who are to launched in December. The flight of Soviet and Japanese spacemen will last eight days.

And now further plans. Two more international crews are to fly in space next year. In May, a British spaceman is to be placed into orbit, and in November, that's next year, an Austrian cosmonaut will fly in space. In 1992 there will be three more international expeditions with a West German cosmonaut to fly in March, a French spaceman to stay at the orbital station Mir in August and a Spanish cosmonaut in December that year.

'Lomonosov' Astrometry Satellite Project

907Q0107A Moscow ZEMLYA I VSELENNAYA in Russian No 2, Mar-Apr 90 pp 10-16

[Article by Doctor of Physical and Mathematical Sciences V. V. Nesterov, A. A. Ovchinnikov, Doctor of Physical and Mathematical Sciences A. M. Cherepashchuk and Candidate of Physical and Mathematical Sciences Ye. K. Sheffer, the State Astronomical Institute imeni P. K. Shternberg of Moscow State University: "The 'Lomonosov' Astrometric Space Project"]

[Text] **A multipurpose astrometric space experiment is being successfully developed in our country.**

Why a New Catalog Is Needed

The basic results of the observations of celestial objects—information about their positions, photometric and spectral characteristics—are summarized in catalogs (ZEMLYA I VSELENNAYA, 1985, No 3, p 62—editor's note). The use of catalogs for practical and scientific purposes always implies the extrapolation of the data contained in them, indeed, figuratively speaking, the observations were conducted yesterday, the catalog is compiled today and it will be used tomorrow. The accuracy of the catalogs inevitably diminishes over the course of time: the positions of the stars change due to their proper motions and parallaxes and their brightness and color also frequently have changed. Whereas, today, the position of a star has been determined with an accuracy to within tenths of a fraction of a second, after 10-20 years, it will contain an error now measurable in whole seconds.

But now, in order to obtain basic results in astronomy, what is needed is a catalog which includes the coordinates of several hundreds of thousands of stars for the entire sky with an accuracy of 0.005-0.010 seconds over a period of several dozens of years, as well as photometric information about them with an accuracy to within 0.05^m in several colors. Creating such a catalog requires multiple observations, performed with even greater accuracy.

However, on the earth's surface, in principle, it is impossible to attain an accuracy for mass measurements greater than 0.10 second. The limit to increasing accuracy is caused by the local fluctuations of the atmosphere and the inadequate stability of the selected directions which give zero-points, as well as the imperfect nature of the measuring instruments which are susceptible to the influence of gravity. An increase in the number of observations, for all practical purposes, does not lead to an increase in accuracy after the attainment of the limiting value. Thus, the pole star has been observed thousands of time over the last 300 years, however, its coordinates are known to us as before with an accuracy of only several hundredths of a fraction of an arc second. The best of the currently existing reference systems is the international FK5 catalog which contains information about 1,670 stars with an accuracy of 0.03-0.10 seconds.

Using the Capabilities of Space Technology

Of all the technical innovations and latest methods, only an astrometry satellite gives real hope of constructing for the entire celestial sphere a uniform reference system which would have an accuracy exceeding the limit for ground-based observations by 1-2 orders. This system is free from local inhomogeneities and global differences which occur at the present time between the two hemispheres of the celestial sphere. The use of the satellite will make it possible to escape the distortions inherent in ground-based astrometric observations and to achieve a high rate of productivity for the scientific measurements.

The establishment of a highly accurate coordinate system for the entire sky, which could be used for a sufficiently long time and which would provide a solution for a whole series of applied and basic problems, was also the main goal of the development of the Soviet Lomonosov astrometric project. This goal should be attained as a result of the integrated work, the basis of which is the space experiment, that is, the organization of observations of stars using a telescope installed on a manmade satellite. The project's development is being carried out by the State Astronomical Institute imeni P.K. Shternberg of Moscow State University, the NPO imeni S.A. Lavochkin, the State Optics Institute imeni S.I. Vavilov and VNII Televideniya [the All-Union Television Scientific Research Institute]. In the near future, the question of its financing should be solved.

An important component of the project is the ground-based support for the space experiment, which includes the establishment of an input catalog of 400,000 stars and the conducting of highly accurate ground-based observations of the stars and other celestial objects.

Specifically, the program of observations for the Lomonosov experiment includes:

—all the stars down to 10.0^m (around 400,000, that is, around 10 stars per square degree of the sphere);

—the fainter (down to 13.0^m) stars (around 8,000), which have already been selected for the European Space Agency's Hipparcos program (ZEMLYA I VSELENNAYA, 1989, No 1, p 69—editor's note);

—around 30 of the brightest sources of extragalactic radiation;

—around 40 bodies of the solar system (large and small planets).

During the realization of the project, the angular distances between the above-listed objects will be measured from on board a space vehicle (KA). The ground-based observations of selected celestial objects will make it possible to bring about an absolute fixing of the future catalog to the equatorial coordinate system. This will result in the compilation of a catalog which will cover the entire sky and which will include the positions, proper motions and parallaxes of 400,000 stars down to 10^m with an accuracy to within 0.002-0.010 seconds. the

catalog will maintain adequate accuracy over the course of 30-50 years. Its first version may be obtained by 1996.

The Expected Result

One of the basic results of the Lomonosov project will be the establishment of a long-lasting highly accurate coordinate system. It is necessary for the needs of ground-based astrometry, geodynamics, geodesy, the study of the solar system's kinematics and so on.

In particular, the absolute proper motions will be determined for a hundred times greater number of stars and many hundreds of time fainter stars than in the star catalogs of comparable accuracy (FK4, FK5). the accuracy of the data will be 5-10 times greater than in the catalogs of comparable volume—ACK3 and SAO. To achieve such results from the ground would require around 100 years of work.

The absolute positions will be determined 10-30 times more accurately than in the FK5 catalog. What is even more important—a uniform accuracy will be attained for the entire celestial sphere and, in particular, the system's differences in the northern and southern hemispheres, inevitable during ground-based observations, will be overcome.

The perfection of the coordinate system will be brought about as a result of the joint observations from on board a space vehicle of the stars and sources of extragalactic radiation (quasars) and of the stars and the bodies of the solar system. On the other hand, these connections are being established according to the observations of celestial objects from the earth's surface using classical optical methods, while quasars are being observed using the radio-interferometry method. Thus, the Lomonosov project's catalog may become a representation of the best of the absolute coordinate systems realizable at the present time.

The perfection of the coordinate system will lead to the overcoming of serious systematic errors in the research on such processes as the galactic rotation and the differential rotation of the stars in the vicinity of the sun; the motions of individual groups of stars and the spiral arms of the galaxy; and the motions of the stars perpendicular to the galactic plane. In addition, the perfection will produce the opportunity for determining the connection between the dynamic reference system (the planets and the moon) and the absolute geometric system; for investigating the non-gravitation effects in the moon's motion and the relativistic effects in the motion of the solar system's other bodies; for establishing a reference system for measuring the precession of the earth's axis and obtaining as a result more accurate data about the special features of the earth's internal structure; for establishing a reference system for the study of the age-old wandering of the earth's poles, the movements of the lithospheric plates and the variations in the earth's moments of inertia; and for establishing a reference system for the study of age-old effects in the motion of the planets and for defining their masses more precisely.

The Contribution to Stellar Astronomy and Astrophysics

The realization of the Lomonosov project will make it possible to obtain new information also in the field of stellar astronomy and astrophysics. The most substantial thing here is the obtaining of absolute trigonometric parallaxes for a large number of stars with a high relative accuracy. At the present time, information is available about the parallaxes of around 10,000 stars, mainly of the northern hemisphere of the sky. Of them, only 5 percent have relative errors which do not exceed 10 percent. After the realization of the Lomonosov project, the parallaxes of hundreds of thousands of stars will have been measured with an absolute accuracy of 0.001-0.002 seconds and this means that the distances to them will also have been determined and, at the same time, there will be a sharp increase (by a factor of 10) in the volume of investigated space, the boundary of which will now turn out to be 1,000 parsecs from earth.

An increase by a factor of 5 in the accuracy in the determination of the parallaxes will make it possible to increase by the same factor the accuracy in the determination of the distances to the stars. And this means that the luminosities of stars at a distance of 10 parsecs will have been determined with an error in all of only 0.04^m. There will also appear an opportunity for determining the trigonometric parallaxes of individual members of star clusters, in particular Hyades, which will substantially define more precisely our information about the distance to this cluster which is the starting point for establishing the scale of distances in the universe.

An increase by a factor of 1,000 in the volume of space in which the trigonometric parallaxes have been determined means that, for the first time, the parallaxes of B class stars of the main sequence of the Hertzsprung-Russell Diagram and the K and M class giants can be measured and their luminosities determined. The parallaxes of F- and G-stars of the main sequence (there are around 15,000 of them within a radius of 75 parsecs with a brightness greater than 11^m) can be used for studying the relationship of their luminosity to the chemical composition.

The number of binary systems, in which the masses of the stars may be determined with an error rate of less than 15 percent will increase approximately by a factor of 10.

The observations of the proper motions of celestial objects will make it possible to determine their spatial velocities and orbits within the galaxy and, by extrapolation according to the time scale for hundreds of millions of years ago, to determine the localization of the star-formation sites.

The Space Experiment

The space experiment which is going to be carried out within the framework of the Lomonosov project, in

general terms, comes down to the following. A Cassegrain telescope, with an equivalent focal length of 50 meters and a main mirror 1 meter in diameter (with a focal point of 4 meters) and an aberration-free field of view of 6 minutes or 90 mm, will be installed on board a space vehicle. A set of aperture mirrors in front of the telescope's inlet will collect in a single field of view the images of two stars (or more accurately, two sections of the celestial sphere) which are separated in the sky by an angular distance of around 90°. Through their relative position, the aperture mirrors should create a highly stable angle standard. During the experiment, the difference between the actual angular distance between the stars and the standard value will be measured.

It has been proposed that a CCD matrix consisting of 800 x 800 elements be used as the receiving recording equipment (ZEMLYA I VSELENNAYA, 1987, No 5, p 43—editor's note). The linear dimensions of each element is 15 x 15 micrometers, which corresponds to 0.06 second. Analysis of the matrix' signal using special digital algorithms will make it possible to find the distance between the stars in the field of view with an accuracy to within 0.3 micrometer, which amounts to around 0.001 second.

The strategy for the conducting of the experiments consists of the device being aimed by one of the optical axes on a selected star (arbitrarily called the reference star), located in a direction away from the sun. Then the device rotates around this axis so that its second optical axis, perpendicular to the first, is aimed at one of the so-called program stars. Upon achieving spatial stabilization, the space vehicle produces a recording of the images of both (the reference and the program) stars on the CCD matrix. After this, the space vehicle rotates around the direction to the reference star, recording during this the image of the remaining program stars which lie in the plane perpendicular to the direction to the reference star. At the same time, photometric measurements are made of the program stars and spectrophotometric ones of the reference stars.

A basic requirement for the arrangement of the space vehicle is the capability for rapidly reorienting it with subsequent triaxial stabilization. It is necessary that, after a gradual gaining of speed around a given axis, it amount to around 0.5° per second. The accuracy of the space vehicle's attitude upon completion of a turn should be no worse than 1-2 minutes. The residual angular velocities of the space vehicle after completion of triaxial orientation should not exceed 0.4 second per second. With these conditions, considering that, from one measurement to the next, the space vehicle should turn on the average by 1.25°, it is possible to produce 2-3 measurements a minute or around 1.2 million measurements over a year of "pure" time.

The telescope's special features and the CCD matrix' characteristics will make it possible to accumulate on the matrix around 40,000 electrons from a $10{,}0^m$ A0 class star over 1 second. Taking into account the fact that the star's image is distributed on 4 x 4 elements of the matrix, we find that in order to achieve a photometric accuracy of 1 percent during the observation of faint stars (10^m), an exposure of up to 4 seconds is required. The maximum exposure time for very faint objects (for example, quasars) may reach hundreds of seconds. The exposure time for the program stars is set automatically by the on-board computer.

The selection of the space vehicle's orbit has been conditioned by the need to minimize the various types of interference: light interference from the Earth and the Moon and interference from the Earth's radiation belts on the CCD matrix. In addition, taken into consideration was the desirability of the space vehicle remaining in the useful section of the orbit as long as possible. As a result, a 48-hour orbit with an apogee of around 120,000 km was selected. The inclination of the orbital plane to the ecliptic plane should amount to 50-60°, which will make it possible to lessen the seasonal influence of the earth's magnetospheric plume, which creates additional interference on the CCD matrices.

In order to carry out the whole set of the space experiment's observations in the optimum mode, it is necessary to calculate beforehand all the angles of the space vehicle's turns, that is, to have available a list of all the stars of the future catalog with approximate coordinates (the input catalog). Its compilation is an important and labor-intensive task which is being solved based on the photographic materials from the observations of USSR observatories in both hemispheres, as well as the data from the Sky Map international astrographic catalog.

Directly associated with the input catalog is the planning of the space experiment and its optimization. This is necessary for the conducting of the maximum number of independent measurements within the minimum time frames and for obtaining the best possible conditional set of equations in the final stage, which is necessary for the reconstruction of the coordinates according to the measured distances between the stars. In the optimum plan, what should be ensured are:

—the selection as reference stars of stars (approximately 3,000) in a band of plus or minus 35° around the ecliptic, which should be solitary, non-variable, relatively bright ($7\text{-}9^m$) and well identifiable against the background of the rest of the stars, while their coordinates should be fixed with an adequately high degree of accuracy;

—the matching to each reference star of a zone 90° distant from it, with a width which corresponds to the telescope's field of view (all the stars of a zone are considered to be program stars);

—the covering of the entire sky with these zones;

—observations of each program star with at least two reference stars so that the angular distance between the latter would be close to 90° (this is necessary for

the reconstruction of the coordinates according to the angular distances between the stars);

—a reiterated observation of each star with an interval between observations of around half a year, which is necessary for the determination of the parallaxes;

—the separation of the proper motions and the parallaxes;

—the checking of the distance of the viewable section of the sky from the Sun, the Earth and the Moon and checking for the entry of asteroids and large planets into the telescope's field of view;

—the capability of selecting from the entire set of measurements only those which will make it possible to compile a summary catalog for a limited number of stars (around 20,000).

After completion of all the measurements and prior to the compilation of a summary catalog, it is necessary to list the entire set of observations in a common coordinate and time system. It will be necessary to solve the set of linear equations, each of which connects a given specific measurement with 10 unknowns (5 for each of the stars).

The project's final stage is the perfection of the coordinate system, in the course of which its connection to the different systems of the physical bodies is carried out.

Hipparcos and Lomonosov

The conducting of mass astrometric and photometric measurements using a telescope installed on a space vehicle has been accomplished, as is well known, also in the Hipparcos project which was developed in 1975 by the European Space Agency. Included in this project's program were around 100,000 specially selected stars with a brightness down to 13^m. Each of them was supposed to be observed 60-80 times with an accuracy for a single observation of around 0.01 second. The basic observation instrument is a Schmidt telescope, installed on a satellite, with a focal length of 140 cm and an inlet pupil 29 cm in diameter. Two fields of view of 0.9 x 0.9°, separated in the sky by an angle of 58°, are projected onto a common focal plane.

The launch of the Hipparcos satellite was accomplished on 8 August, 1989. However, the vehicle did not reach the calculated orbit and, therefore, doubts arose among the specialists about the feasibility of carrying out fully the research program (more details about this can been read in the preceding issue of our magazine—editor's note).

Used in the Lomonosov and Hipparcos projects are different means for surveying the celestial sphere and methods which differ in principle for recording the positions of the stars in the focal plane. In the Western European project, the survey of the celestial sphere is accomplished as a result of the rotation of the space vehicles and the precession of the axis of rotation and this is why precise knowledge about the position of the space vehicle's axis of rotation in space and the angular velocity of the rotation is needed for the calculations of the stars' coordinates.

The projects are also differentiated by the principles for the recording of the positions of the stars in the focal plane: in the Soviet project, the image of a pair of stars is recorded simultaneously, while, in the Western European project, the recording is divided in time, which leads to significant complication of the processing of the data.

Whereas, for the Lomonosov project, an input catalog of the stars' positions with an accuracy of 1-3 seconds is needed, for the realization of the Hipparcos project, the accuracy must be one order higher, which required around 15 years of ground-based observations performed by a large group of scientists. As a result, the cost of the input catalog was comparable with the cost of the entire space experiment.

The Lomonosov project also has an advantage in that the connection of the stars to bright quasars will now be conducted in the course of the experiment. The coordinate set obtained as a result of the realization of the Hipparcos project can be connected to the quasars only after the realization of the American Space Telescope project, the start of which has been planned for 1990.

The Soviet and Western European projects could complement each other quite well if the possible errors of the methods are determined and excluded, thereby increasing the trustworthiness of the obtained scientific data.

Gamma Observatory Changes Orbit

LD1307210290 Moscow TASS in English 2057 GMT 13 Jul 90

[Text] Mission Control Center July 14 TASS—The automatic Gamma observatory put into orbit on July 11, 1990 continues its mission.

The observatory performed three maneuvers during the first three days of the flight, after which it was put into a working orbit with the following parameters:

Initial period of revolution—93 minutes,

apogee—438 kilometers,

perigee—419 kilometers,

orbital inclination—51.6 degrees.

In the forthcoming three weeks, the Control Center will conduct test initiations of the laboratory's various systems and tune up the operation of scientific instrumentation, which will help adjust the best modes of their operation.

'Granat' Satellite Completes Initial Research

LD0309131590 Moscow TASS in English 1302 GMT 3 Sep 90

[Report by TASS correspondent from the Space Communications Center]

[Text] Simferopol September 3 TASS—The first stage of scientific research, under an international program, has been completed aboard the space observatory "Granat," launched on December 1, 1989.

More than 140 observations were made during the flight of various sections of the celestial sphere, including research into the sources of X-ray and gamma radiation in the large Magellanic Cloud, of the 1988 supernova, the galaxy clusters, the central zone and our galaxy. Other objects of investigation included the nucleus of active galaxies, quasars, X-ray pulsars and potential black holes. Approximately 18 hours a day were devoted to research.

Experiments yielded X-ray pictures of the central part of our galaxy and of rich clusters of galaxies in the constellations Virgo, Perseus, Coma Berenices and Centaurus. Measurements were taken of the period of revolution of eight neutron stars [word indistinct] X-ray pulsars. The spectrum and time structure of 100-odd sources of gamma-bursts were investigated. A hitherto unknown X-ray source, called "'Granat' Source," has been discovered.

Soviet and foreign specialists are monitoring the satellite and the on-board scientific equipment from the Space Communications Center. The "Granat" space observatory will continue its research.

UDC 65.012.2:629.198.3

Increasing the Information Content of Satellite Observations of Ground Targets

907Q0074A KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 28, No 1, Jan-Feb 90 (manuscript received 2 Nov 88) pp 56-68

[Article by M. Yu. Belyayev and D. N. Rulev]

[Abstract] Few orbits satisfy all the conditions required for proper viewing of ground targets from satellite. The information content of such observations can generally be increased by way of flight maneuvers, which are subject, however, to a number of constraints. The work reported in the article involves determining the orbital parameters of a satellite that maximize the information content of the observations and minimize the energy expenditures associated with the necessary orbital maneuvers. The satellite in the models used was moving in a circular orbit with a constant inclination relative to the equator. The problem was solved with linear programming. The effectiveness of the approach was demonstrated in the context of the orbital parameters of the Mir station. Figures 1, references 4 (Russian).

UDC 551.510.536

Specialized Aeronomic Model for Studies of Artificial Modification of the Middle Atmosphere and the Lower Ionosphere. II. Compilation of Results of Calculations With Experimental Data

907Q0074B KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 28, No 1, Jan-Feb 90 (manuscript received 16 Dec 88) pp 77-84

[Article by N. V. Smirnova, S. I. Kozlov, and V. A. Vlaskov]

[Abstract] A specialized aeronomic model developed earlier by the authors (KOSMICH. ISSLED., 1988, Vol 26, No 5, p 738) for studying the behavior of an environment artificially disturbed by various sources is verified with experimental data that include measurements performed during the natural polar-cap-absorption events of 2-4 November 1969 and 13 July 1982. The reason for the inclusion of the data on natural disturbances is that little data exists on artificial disturbances. The authors point out that during the polar-cap events, the level of changes in the ionosphere may be somewhat lower than it is with a number of artificial disturbances. In addition, the large amount of data on the behavior of electron concentration n_e and on variations of trace neutral components during such disturbances makes it possible to evaluated the accuracy of the model's description of the behavior of the parameters of the lower ionosphere and the middle atmosphere in conditions that are rather varied in terms of degree of disturbance, season, and time of day. The artificial disturbance data includes riometer measurements of the absorption of radio waves at $f = 30$ MHz on Midway Island during operations involving the research vessel *Morskaya Zvezda*. Principal absorption of the radio waves was at altitudes of $h < 100$ km. Figures 4, references 26: 11 Russian, 15 Western.

UDC 581.521

Substorm Effects in Varying Fluxes of Energetic Particles on the Day Side of a Geostationary Orbit

907Q0074C KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 28, No 1, Jan-Feb 90 (manuscript received 18 Jan 89) pp 94-102

[Article by T. A. Ivanov, M. I. Panasyuk, V. P. Pishchikov, and G. V. Popov]

[Abstract] It is well established that variations in the fluxes of energetic protons at the periphery of the radiation belts have nonadiabatic (or injection) components and adiabatic components. Techniques for determining the time of injection and the longitude of the region of generation have been developed for the nonadiabatic components. Analysis of the link between accelerated-particle fluxes and the formation of the large-scale DP2 current system, on the one hand, and surface magnetic

auroral activity, on the other, has shown that the sharp drop in the H component at high-latitude, near-midnight stations serves as a good indicator of the beginning of the injection process. The appearance of Pi2 pulsations, the authors point out, also serves as evidence of the breakup of substorm process. In terms of the role of adiabatic variations, researchers have studied the change in energy levels of particles as a result of the gyrobetatron effect and drift-betatron acceleration. The principal difficulty in arriving at an adequate explanation of the experimental results is generally the result of the absence of data on magnetic field changes in various regions of the magnetosphere. Analysis of particle behavior that is generally determined by various factors is rather complex, and the authors here have addressed the problem of separating injection processes and adiabatic variations. Data collected by the geostationary Gorizont (1984-78A) communications satellite during the 4 September 1984 magnetic storm was used to study the flux variations for protons with energies of 30 keV to 2.8 MeV. The data are compared with those of ground magnetic observatories and those of the AMPTE/CCE satellite. The authors conclude that proton variations of 4 September 1984 were the result, primarily, of two processes: (1) the injection of particles that took place at 06:18 UT near midnight and that coincided with the beginning of the sharp drop in the H component at high-latitude stations and with the beginning of the Pi2 pulsations at the Irkutsk station; and (2) the abrupt particle acceleration. Typically, a variation caused by augmentation of the magnetospheric field is superimposed on the particle variation caused by the injection near midnight. Figures 4, references 13: 1 Russian, 12 Western.

UDC 551.521.8

Dynamics of Fluxes of Solar-Wind Heavy Ions and of Certain Solar Corona Characteristics

907Q0074D KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 28, No 1, Jan-Feb 90 (manuscript received 28 Nov 88) pp 103-116

[Article by Yu. I. Yermolayev and G. N. Zastenker]

[Abstract] Measurements of the elemental (mass) and charge composition of solar wind are of great interest to researchers because they provide direct evidence of the chemical composition and temperature of the solar corona. Although long-term solar-wind research has produced a rather large volume of data on mass composition, ionization temperatures, and the relationship of heavy-ion velocities and kinetic temperatures, the parameters retrieved for trace ion components usually are either averaged over long time intervals or pertain to relatively short periods of time. The authors undertook to study the dynamics of the parameters and to compare them with the results of measurements of the characteristics of solar-wind flux. Prognoz-7 measurements of proton, α-particle, and heavy-ion fluxes in solar wind (November 1978-June 1979) showed that heavy ions are constantly present in solar wind and can be recorded virtually any time conditions permit observation. Six intervals of low- and medium-velocity solar wind lasting 1.5-3 days were observed. During those intervals, oxygen, silicon, and iron ions were continually recorded, and the average values for content and ionization temperature were in good agreement with the data of other experiments. The average hourly and daily values for ionization temperatures remained fairly constant, indicating that coronal temperatures were very stable for the sectors that were the sources of the low- and medium-velocity wind. The average hourly and daily values for the content of ions of oxygen, silicon, and iron varied dramatically in relation to hydrogen, by almost an order of magnitude. The average daily content of heavy ions (and helium) in the solar wind diminished considerably with elevations in proton concentration, that change being approximately proportional for all ions. Figures 4, references 23: 5 Russian, 18 Western.

UDC 550.81.523 3

Microcraters on Targets Exposed in Near-Earth Orbit

907Q0074E KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 28, No 1, Jan-Feb 90 (manuscript received 18 July 88) pp 117-124

[Article by N. G. Zinovyeva, O. D. Rode, G. A. Kuzin, M. R. Kondratyeva, and A. T. Bazilevskiy]

[Abstract] Two copper plates and one aluminum plate (each 2.89 sq cm) were exposed to open space in near-Earth orbit (approximately 350 km in altitude) for nearly four years. A plate of quartz glass (10 sq cm in area) coated with a titanium film 0.5 μ thick was similarly exposed. The authors set out to study the morphology of the microcraters formed on the targets, as well as the density and size distribution. In looking for residues of the material that struck the targets, they determined the chemical composition of the target surfaces, of the crater walls and bottoms, of the near-crater space, and of unusual relief forms. The craters on the metal targets were distinct and homogenous in form. Those on the glass varied in form, because of the brittleness of the target and because of its two-layer structure. On the metal, higher collision velocities resulted in the growth of the ratio of crater depth to diameter; on the glass, the degree of morphological distinctiveness became greater. The greatest density of craters was with those with a diameter of under 2 μ. Density fell off as crater size increased. The authors estimate that the targets were bombarded by particles with diameters under 5 μ at a rate of (2-40) x 10^{-3} particles/sec; by particles with diameters greater than 5 μ at a rate of (1-2) x 10^{-4} particles/sec. The particles consisted of interplanetary space dust and orbital fragments of manufactured materials. Figures 3, references 4: 2 Russian, 2 Western.

UDC 543.591

Time Variation of Intensity of Ions of Anomalous Oxygen Near Earth

907Q0074F Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 28, No 1, Jan-Feb 90 (manuscript received 27 Dec 88) pp 155-157

[Article by N. L. Grigorov, D. S. Zhuravlev, M. A. Kondratyeva, Ch. A. Tretyakova]

[Abstract] The time variation of the intensity of oxygen ions in near-Earth interplanetary space is described. The time track is based on regularly performed observations of ions with charges of Z greater than or equal to 6 during the 11-th solar cycle, between 1984 and 1988. Small plates (10-50 sq cm) of several layers of cellulose nitrate were exposed on a Kosmos satellite with an angle of inclination of approximately 70° at altitudes of 300-400 km. The detectors that were used identified the charges of C, N, and O nuclei on the plates and determined their energies in the interval of 4-20 MeV/nucleon. More than 30 expositions were performed, each lasting about 14 days. Some coincided with solar proton events; most were done during quiet solar periods. Mid-1985 marked the beginning of the detection of fluxes of ions similar in characteristics to the anomalous component of cosmic rays: hard energy spectra and predominance of oxygen ions in the flux. Over a two-year period of observation, the intensity of the oxygen ions grew by more than an order of magnitude, with the maximum recorded in May 1987, after which there was a rather abrupt drop. After comparing their data with those of ISEE-3, IMP-8, and Voyager 2, the authors conclude that the intensities recorded in the Soviet experiments in 1986 agree with the ISEE-3 and IMP-8 measurements and that the time variation of the intensity of oxygen ions recorded by the Soviets in 1985 and 1986 matches in the first approximation the time variation of the intensity of anomalous oxygen in the heliosphere near the plane of the ecliptic. Figures 1, references 10: 3 Russian, 7 Western.

UDC 524.7-7

Comparison of UV Fluxes of 19 Galaxies Obtained on the Astron Astrophysical Station With the Results of Earth-Based Photometry. The Variability of UV Fluxes of Some Galactic Nuclei

907Q0125A Moscow ASTRONOMICHESKIY ZHURNAL in Russian Vol 67 No 3, May-Jun 90 (manuscript received 4 Sep 1989) pp 449-462

[Article by N. I. Merkulova, L. P. Metik, V. I. Pronik, I. I. Pronik, USSR Academy of Sciences Crimean Astrophysical Observatory]

[Abstract] UV flux observations (1600-3500 Angstrom) were made from the Astron satellite with a 33" elliptical diaphragm. UBV-system Earth-based observations consisted of fluxes calculated for a 60" diaphragm or detailed photometry of galactic centers.

Different types of galaxies (types E to Ir) were studied, and for most galaxies the divergence of fluxes did not exceed $\Delta \log F(60") \leq \pm 0.1$.

Larger divergences were detected for NGC 1569, 3448, 598, 5236, and Mkn 573. The divergences are attributed to variability of the galactic nucleus radiation. NGC 598 and 5236 are believed to have nuclei similar to the Seyfert nucleus of NGC 4051. The central variable source is surrounded by a dense envelope of neutral hydrogen. The size of the nucleus and envelope is assumed to be $\geq 10^{17}$, and the average density of hydrogen atoms is $6 \cdot 10^4$ cm^{-3}.

It has been found that the ejecta of NGC 4486 changes brightness over time. Figures 6; references 40: 12 Russian 28 Western.

UDC 524.352

SN 1987A: Analysis of UV Absorption Spectra Obtained from the Astron Station

907Q0125B Moscow ASTRONOMICHESKIY ZHURNAL in Russian Vol 67 No 3, May-Jun 90 (manuscript received 21 Jul 1989) pp 480-493

[Article by L. S. Lyubimkov, USSR Academy of Sciences Crimean Astrophysical Observatory]

[Abstract] The Astron station tracked the evolution of the absorption spectrum of SN 1987A for about 400 days after the explosion. The effective temperature of the supernova was taken to be 5000 K. The blend at 3230 angstroms was used to determine radial velocity.

The correlation between the radial velocity and time can be approximated by a power law. It is found that radial velocity is decreasing over time, not due to a slowing of expansion, but due to rarefaction of the ejecta.

Ionization of Fe I is increased due to nonequilibrium conditions in the envelope, and these conditions may weaken the lines of neutral atoms, leaving the lines of ionized atoms unchanged. The weakness of the Fe I lines is observed in a spectrum of SN 1987A. The same is true of other iron group elements Titanium plays a key role in the blends of the UV spectrum.

It was assumed that the initial metal content of SN 1987A was a factor of 3 lower than the metal content of the Sun. Absorption blends became more intense after day 120, and this may be due to titanium synthesized in the envelope in the explosion. Figures 6; tables 2; references 35: 12 Russian 23 Western.

UDC 523.66

Study of Periodicity in the Rate of Gas and Dust Formation in Comet Halley in October-December 1985

907Q0125C Moscow ASTRONOMICHESKIY ZHURNAL in Russian Vol 67 No 3, May-Jun 90 (manuscript received 23 Nov 1989) pp 636-641

[Article by A. P. Vidmachenko, V. K. Rozenbush, K. I. Churyumov, Main Astronomical Observatory of Kiev State University, USSR Academy of Sciences]

[Abstract] The period of rotation of a comet is vital information which can be used to derive much information about the comet. One way of determining the period of rotation is by studying the release of gas and dust from the comet.

The periodicity of gas and dust formation was studied before the comet's perigee (October-December 1985) using photometric observations. A burst of activity on November 15-20 affected the photometric data and was accounted for in the calculations.

Periods of rotation of the cometary nucleus of 2.2 days and 7.4 days were confirmed. The former was detected from analysis of the structure of the nucleus, coma, and tail; the latter, from photometric data. A 10.3 day period component was also found, but an explanation of its significance requires the analysis of additional observational data. Figures 1; tables 2; references 14: 4 Russian 10 Western.

UDC 681.3:523.164.8

Venera-15 Bistatic Radar Studies of the Northern Polar Region of Venus

907Q0075A Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 28, No 1, Jan-Feb 90 (manuscript received 24 May 88) pp 125-133

[Article by A. G. Pavelyev, O. I. Yakovlev, O. N. Rzhiga, A. I. Kucheryavenkov, R. S. Andrevev, A. I. Zakharov, S. G. Rubashkin, and R. R. Salimzyanov]

[Abstract] Results are presented from bistatic radar studies of two areas of the northern polar region of Venus, and the data from those studies are compared with radar images of the planet. The first of the areas studied begins at 74° N lat, 225° long. The track of the study proceeds mainly along a plain 500-700 km south of the Snegurochka [Snow Maiden] Plain and ends at 71.5° N lat, 240° long. Surface elevation in that area ranges from 0 km to 0.5 km. The second area begins at the Rudnev Crater near 79° N lat, 178° long and ends at 78.8° N lat, 198° long. Elevation ranges from 0 km to 0.5 km in the middle of the track and from 0.5 km to 1 km at the end of the track. During a mapping session, the planet's surface was irradiated with unmodulated radio waves at λ = 32 cm from Venera-15. The radio waves were reflected to Earth from a relatively small surface area with its center at the arbitrary mirror reflection point *D*, which shifted as a result of the the motion of the spacecraft. In processing the data, researchers determined the dispersion of the slopes of random relief irregularities with a horizontal scale of from 1-1000 m (γ^2), the return loss of the reflected waves (η^2), and the angle of refraction the radio waves in the atmosphere(ξ). In terms of surface reflectivity and roughness, the studies revealed that the first area is about 2-3 times less rough than the second area, but 1.5-2 times more reflective. The lowest γ values were found at 73.4° N lat, 228° long (approx. 0.15°). The highest γ values were found in the second area, in the region near the end of the radar track (0.9-1.0°). The values for η were lower than the theoretical values by 1.5-6 dB. Figures 7, references 14: 9 Russian, 5 Western.

UDC 523.72

Instabilities at the Boundary of the Venusian Ionosphere

907Q0075B Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 28, No 1, Jan-Feb 90 (manuscript received 9 Sep 89) pp 134-150

[Article by Ye. V. Belova and L. M. Zelenyy]

[Abstract] The instability of the Venusian ionopause caused by velocity shear between the solar-wind plasma in the ionopause and the quiescent ionospheric plasma is examined in the context of the assumption that wavelength is determined by the typical dimensions of the structures observed near the ionopause (magnetic flux ropes, plasma clouds). The authors take ionopause thickness (*L*) and Larmor radius (ρ_i) into consideration, as well as plasma compressibility. They also study the effect of the charging of solar wind with planetary ions (as a result of recharging and photoionization). In their model, consideration of the finiteness of *L* suggests that the length of the most unstable wave has a value of λ_{dom} approximately equal to $4\pi L$, which is approximately equal to 300-600 km. The effect of the charging of solar wind on the instability is substantial only at low ionopause altitudes, where the instability stabilizes as a result of recharging. Finiteness of the Larmor radius leads to asymmetry in the development of the instability, such that its rates of development are different on the different sides of the magnetic equator. In addition to large-scale instabilities (in which λ is greater than or approximately equal to *L*), local instabilities may be generated whose typical wavelength is determined by the Larmor radius (λ is approximately equal to $2\pi\rho_i$, which is approximately equal to 60 km). Small-scale instabilities may serve as the mechanism of formation of magnetic flux ropes in the ionosphere (ropes probably form when magnetosonic instabilities develop, the latter leading to a growth in the longitudinal component of the magnetic field and the formation of fibrous structures). The authors conclude the longwave Kelvin-Helmholtz instability cannot explain the collapse of the large-scale magnetic field into the ionosphere, because at high dynamic solar-wind pressures, when such fields are observed in the ionosphere, the instability must stabilize as a result of recharging. Large-scale instabilities, however, can form at the ionopause, and the authors see them as a possible mechanism for the formation and separation of plasma clouds. Figures 6, references 27: 6 Russian, 19 Western.

528.711.7:621.396.969:523.42

Mapping the Surface of Venus

907Q0057 Moscow GEODEZIYA I KARTOGRAFIYA in Russian No 2, Feb 90 pp 8-11

[Article by Yu. S. Tyuflin]

[Abstract] Almost 100 years after the first aerial survey in Russia was performed (from a balloon 800 m above Peterburg), the mapping of Venus was begun by the Venera-15 and -16 spacecraft flying 1,000-2,000 km above the planet's surface. Side-looking radars developed by the Special Design Bureau of the Moscow Power Engineering Institute were used to peer through the dense atmosphere. The survey package aboard each spacecraft consisted of a radar that operated at 8 cm and looked down at an angle of 10° from the vertical and a radar altimeter that measured the topographic profile along the track of the flight. Each orbit produced a panorama that covered some 700,000 sq km with a resolution of 1.5 km, and each measurement session lasted about 15 minutes. The survey information was recorded digitally and was transmitted back to Earth

during communications sessions. The spacecraft surveyed the northern regions of the planet (!15,000,000 sq km), including a previously inaccessible "blank spot" that measured about 9,000,000 sq km. The survey materials were processed and interpreted through the cooperative efforts of more than a dozen Soviet organizations. The radar panoramas—based on echoes from "radar bright" areas—were the raw materials for the interpreting, the creation of maps, and the plotting of a network of reference points. Each of a panorama's elements was based on spherical coordinates in a planet-centered orbital system of coordinates, and a cylindrical, quadratic, equal-interval projection was used as the map projection. Terrain point coordinates were tied to the radar panorama via geodesic measurement of angles from the center of the projections, the spatial position of which corresponded to only one given terrain point. The angular elements of the spacecraft orbits and the angles that defined the position of the north rotation pole of Venus and the direction of its zero meridian in a geocentric systems of coordinates of standard epoch served as the parameters for converting the spherical coordinates into a planet-centered system. Photoplans created by computer were used to construct maps of lineaments and rose diagrams of their strike. After the horizontals on the photoplans were analytically plotted, the horizontals formed with only the digital models of the terrain were laid out by hand. The survey and its subsequent processing contributed to photogrammetry by way of its new geometric model of forming radar panoramas, its new approach to determining resolution and eliminating systematic errors on radar images, its new formulas for tying panorama coordinates and terrain, its new equations and techniques for solving photogrammetry problems, and its new principles of stereoscopic perception of overlapping images.

NPO Energiya Scientist Refutes Press Charges of Computer Errors in Space Missions

907Q0069 Moscow ZHURNALIST in Russian No 3, Mar 90 pp 50-51

[Article by V. Semyachkin, department head at NPO Energiya, under the rubric "Letters to 'Zhurnalist'": "The Warped Tracks of Space"]

[Text] For decades, the relationship we developers of space equipment have had with the press at home has been of a specific nature. The press, basically in the form of TASS Reports, wrote one thing about us, and we, in turn, thought the exact opposite about the press. But, with the advent of glasnost, the situation has changed radically. Now the press writes something quite different about us, but we—well, we, curiously enough, think practically the same thing about it. For the sake of fairness, though, we must also acknowledge our share of the blame for the situation which has taken shape. Thus, for example, PRAVDA correspondent A. Pokrovskiy, in enumerating the problems which have occurred during space flights, says reasonably: "Of course, equipment is equipment, and anything can happen. But it is necessary also to explain to people in human terms the reasons for the problems." It is, indeed, time.

Recently, the work of the commission on the Soyuz TM-8 was completed. For 12 days, more than a dozen specialists scrupulously analyzed the telemetry data, looked over the video tapes, and listened to the recording of the exchange between the Flight Control Center and the crew. There was one goal: to answer the question, What really happened on 8 September 1989, at 2:21 am, Moscow time, aboard the Soyuz TM-8? Why was the crew, some 5 meters away from the target, compelled to interrupt the automatic approach and docking procedure, take control themselves and, moving off about 10 meters from the station, dock to the Mir station in manual mode? And so the heated debates have come to an end. All the necessary signatures have been placed at the bottom of the "Conclusions." But people's thoughts, for the umpteenth time, return to the events of 1988.

Early on the morning of 7 September 1988, the Soyuz TM-5's international crew, V. Lyakhov and A. Momand, landed safely. The crew landed a day later than originally scheduled. A commission was set up in which my colleagues and I were to determine whether or not the onboard computer had been working correctly. So the tense work began: an analysis of all the telemetry, mountains of printouts, simulation on ground test stands—from morning until late evening. But before going to sleep, you pick up any newspaper at random, and you read: "...the current malfunction of the onboard computer is causing concern"; "the 'third cosmonaut' on the craft needs more careful monitoring and control"—this is what V. Gubarev wrote quite mildly in PRAVDA. The newspaper IZVESTIYA (B. Konovalov) expressed its opinions in more detail and was, perhaps, in terms of the statement of the question, closer than all the others to the truth. From among all the rest, let's take the respected organ of the Union of Writers—LITERATURNAYA GAZETA: "If the malfunctions in the Soyuz TM-5's automatic equipment were in fact as as bad as what the newspapers wrote—that's not very different from the warped tracks near Bologoye or the rocklike buoyancy of the *Admiral Nakhimov*." And the question: "Why should space tracks be completely immune to fatal warping? What, is there less passion there for early reports and window-dressing?"

The latter made a particularly strong impression on my associates, the developers of the Soyuz TM's control system and the developers of the algorithms and software for the onboard computer. Nevertheless, the commission's work was completed in two weeks. The verdict: there were no malfunctions in the operation of the onboard computer, and the onboard algorithms corresponded to the existing documentation. In order to facilitate the crew's actions in similar emergency situations, it was recommended to the control system's developers that they revise the software. The main cause of the crew's daylong torments in the reentry vehicle's cramped cabin was acknowledged to be a combination of incorrect actions of the crew commander and mission control personnel. The organizational conclusions were made, and the necessary instructions given.

There was nothing about this in the newspapers.

December 1988 arrives, and the Franco-Soviet crew is supposed to return to the ground in the Soyuz TM-6. Based on the experience of the previous reentry, everything has seemingly been thought out and taken into consideration. The onboard documentation to cover the crew's actions in emergency situations has been supplemented.

But the pre-reentry orbit gives everyone a shock: the onboard computer fails. Specialists will understand the gravity of the situation which arose. The actual prospect of the crew languishing for 24 hours arose. After all, the emergency reentry is during the third orbit, and that's only three hours away, and the next possible reentry after that couldn't take place for another 24 hours. But now there are not two people in the cabin, as in September—there are three...

But the impossible, as if were, is happening right before my very eyes. The trance has lifted, and my colleagues, the mathematicians and the programmers, have literally sank their teeth into solving the problem. After an hour and a half, everything is clear: the cell in which the "overflow" took place has been found, the entire program sequence has been traced, and the original source has been established. It turns out that the operator of the ground computer, where the information for the onboard computer's navigation program is computed and coded, made an error. The necessary measures are quickly taken, the now correct "condition vector" is sent to the craft, and there is a perfect landing from the third orbit. But, in the newspapers, again there are questions

about when the onboard automatic equipment and onboard software are finally going to stop delaying reentries. Something of a consolation for my colleagues was the NPO Energiya order expressing gratitude to and materially rewarding the group which solved the complicated problem so rapidly.

And now, let's return to this past September and to our commission. But, first, let's glance at the newspaper TRUD. "It concerns us," it writes, "that the automatic docking problem has been a weak spot for us not just for months or even years, but for two decades... It seems high time that a reliable system be developed. So many programs have been ruined in the past because of this, so much money has been lost..."

But what about the commission? Its conclusion is unambiguous—there were no criminals whatsoever in either the onboard computer's algorithms or in the Kurs equipment. The Soyuz TM-8's automatic approach procedure was proceeding exactly as it did on all the preceding seven vehicles, which docked successfully. But, under the difficult conditions of monitoring the approach and docking in the shadow, the crew, their hands full with an unscheduled radio exchange with the ground, mistook the shadow cast by the Mir station's docking target for the target itself. Hence, the mismatch which gave the commander grounds for stopping the automatic mode.

I wrote all this and thought that someone might say, Is it really so important to talks about the details of situation in every case, since the result is the same? I am convinced, however, that it has to be done. For the sake of those people who, in spite of the country's serious general lag in the field of computer equipment, developed an onboard computer which did not have a single failure over the entire time of the flights of the Soyuzes and the Progress-Ms. For the sake of those who developed the Igla radio equipment, the only of its kind in the world, and who subsequently replaced it with the more advanced Kurs. For the sake of my colleagues who developed the onboard control systems.

Of course, equipment is equipment. And as for failures in the onboard equipment—hardly anyone would assert that they can be eliminated completely. The developers of space equipment work with the concept of the "predicted emergency situation." In principle, it allows for the occurrence of a specified number of problems during a flight. At the very same time, a spacecraft—above all, a manned spacecraft—must be built and is built in such a way that the flight program will be executed no matter how many predicted failures.

As the above examples show, equipment failure is not always the source of an emergency situation. And the search for the true cause is a process which is frequently difficult and tedious and requires, first and foremost, time. And that is why journalistic haste is intolerable here.

And last of all. For the information of the correspondents who write on the topic of space. In all, sent into space (prior to 1990) were:

- 40 Soyuzes and Soyuz-Ts with the Igla unit; of those, four did not dock because of the Igla
- 8 Soyuz-TMs with the Kurs, and all of them docked
- 42 Progresses with the Igla; all of them docked
- 2 Progress-Ms with the Kurs; they docked successfully.

P.S. These lines were already written when all the troubles associated with the docking of the Kvant-2 with the Mir station were about to happen. But after two weeks of tense work and a number of emergency situations, the Kvant-2 is hooked up to its intended Mir docking assembly. In the press, several articles have already appeared explaining to the public not only what happened, but also why it happened. Yet, the specialist commission for the analysis of emergency situations has just gotten to work.

UDC 629

Maneuverability of Large Orbital Stations

907Q0073A Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 28, No 1, Jan-Feb (manuscript received 30 Jan 88) pp 3-10

[Article by V. P. Legostayev and Ye. N. Tokar]

[Abstract] Problems involving the maneuverability of orbital stations in the gravity field of the Earth are solved for various types of station attitude, with finite values for their quadrantal angles. The authors pose the problem of a space station that is moving around the Earth in a circular orbit with a period of revolution of T_* and a rate of change of anomaly of its center of mass O such that $\omega_* = 2\pi/T_*$. Chosen for analysis from among the typical attitudes of a space station are a stationary attitude in relation to the inertial system of coordinates, a stationary attitude in relation to the orbital system of coordinates, and angular maneuver (or turn). The authors compute the values for the total kinetic moment of the gyro power systems that give the station various degrees of maneuverability. Figures 4, references 11 (Russian).

UDC 629.78.015

Evolution of the Rotation of a Satellite With a Damping Flywheel

907Q0073B KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 28, No 1, Jan-Feb 90 (manuscript received 08 Aug 88) pp 17-21

[Article by M. L. Pivovarov]

[Abstract] The motion around the center of mass of a satellite stabilized by rotation may differ substantially from axial rotation and may be close to the Euler-Poinsot motion. The transition to a permanent rotation may be made by installing a special passive system on the satellite—a nutational oscillation damper. The simplest such damper is a passive flywheel, which dissipates energy through viscous friction, thereby making an elastic coupling possible between the flywheel and the satellite. In an effort to determine the optimal parameters for such damping, the author takes an approach that assumes that the damper slightly disturbs the rotation of the satellite. Working in the context of a dynamically symmetric gyrostat, with the passive flywheel axis orthogonal to the axis of symmetry of the gyrostat, he then uses asymptotic methods to produce an approximate solution of nonlinear equations in order to find the optimal parameters for effecting the fastest possible diminution of the nutation. Figures 3, references 5 (Russian).

UDC 629.7

Periodic Oscillations of a Satellite-Gyrostat Relative to the Center As Affected by Magnetic and Gravitational Moments

907Q0073C KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 28, No 1, Jan-Feb 90 (manuscript received 25 Oct 88) pp 22-34

[Article by A. A. Voronin and V. V. Sazonov]

[Abstract] The rotational motion of a satellite-gyrostat as affected by gravitational and magnetic moments in a circular orbit in the Earth's magnetic field is examined. The satellite carries a permanent magnet and has a rotating symmetrical rotor whose kinetic moment is constant relative to the satellite and is parallel to one of the main central axes of inertia of the satellite. The dipole moment of the magnet is parallel to one of the other main central axes. The circular orbit of the satellite is invariable in absolute space. Assuming the natural kinetic moment of the rotor and the dipole moment of the magnet to be large, the authors investigate the possibility of triaxial orientation of the satellite in a system of coordinates bound to the intensity vector of the Earth's magnetic field and to the normal to the orbital plane. Three right Cartesian systems of coordinates are used: one for studying satellite attitude, one for the main central axes of inertia, and one for the orbital system. The rotational motion is described with a system of ordinary sixth-order differential equations with periodic coefficients. Analytical and numerical methods are used to construct symmetrical periodic solutions of the system that are close to periodic solutions of a degenerate system whose order is equal to two. Stability in the first approximation is studied. The motions described by such solutions can be used to effect a regime of triaxial magnetic orientation of a satellite in circumpolar orbit. Figures 6, references 9 (Russian).

UDC 629.7

Motion Around the Center of Mass of a Satellite Moving in a Circular Orbit With Viscoelastic Rods and a Contactless Rotor

907Q0073D KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 28, No 1, Jan-Feb 90 (manuscript received 05 Dec 88) pp 35-46

[Article by Yu. G. Markov]

[Abstract] This study of the motion around the center of mass of a complex mechanical system assumes the satellite to consist of a symmetrical solid with four mutually orthogonal viscoelastic rods in the equatorial plane of the inertia ellipsoid. The solid houses a spherical cavity in which a spherical rotor operates in a contactless suspension system. The center of mass of the rotor is assumed to be the center of its outer spherical surface and coincides with the center of mass of the satellite. The center of mass C of the system moves in a circular orbit in a central Newtonian gravitational field, and neither the motion of the satellite relative to its center of mass nor the flexural vibrations of the rods affect the satellite's orbital motion. There is a residual pressure in the space between the rotor and the surface of the cavity in which it is located. The author uses the method of averaging and dividing the motions to produce equations for evolutionary rotational motion. Stationary motions of the system are found and their stability scrutinized. References 5: 4 Russian, 1 Western.

UDC 531.36

Stationary Motions of an Elastic Membrane in a Circular Orbit

907Q0073E KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 28, No 1, Jan-Feb 90 (manuscript received 16 Dec 88) pp 47-55

[Article by S. D. Furta]

[Abstract] The motion of a homogeneous elastic membrane stretched over a rigid, closed contour that is moving in a circular Keplerian orbit in a central Newtonian force field is examined. The rigid contour is attached to a solid whose center of mass is travelling in a circular Keplerian motion without changing its attitude relative to the orbital system of coordinates. The author formulates and proves a theorem for the existence of weak solutions for the equations of motion. The conditions sufficient for the existence of stationary motions and trivial stationary motions are demonstrated and their Lyapunov stability investigated. In one instance, the author solves a problem associated with the bifurcation of trivial stationary motion. Figures 3, references 11 (Russian).

UDC 629.197.2

Algorithm for Calculating the Parameters for Multirevolution Long-Range Guidance Maneuvers

907Q0073F KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 28, No 1, Jan-Feb 90 (manuscript received 19 Apr 88) pp 69-76

[Article by A. A. Baranov]

[Abstract] Four-impulse, long-range-guidance maneuvers that are performed to ensure a soft rendezvous between a spacecraft and a target that are moving in proximate, almost circular orbits is examined. The author uses numerical-analytical procedures to construct an algorithm for determining the parameters of the optimal maneuvers in a class of solutions in which the signs of all the transverse impulses coincide. The impulses are applied during two maneuver intervals separated by no fewer than 10 revolutions. The algorithm was run and verified on a BESM-6 computer and changes when the angles of application of the second-interval impulses are not fixed. Three problems are solved by way of example, and a geometric interpretation of the solution search is provided. Figures 4, references 4: 3 Russian, 1 Western.

551.501.793:551.510.536

Onboard UV Spectrometer BUFS-1

907Q0055A Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 1, Jan-Feb 90 (manuscript received 29 Jun 88) pp 67-73

[Article by D. A. Andriyenko, V. I. Barysheva, V. N. Vashchenko, V. P. Volos, V. A. Danilevskiy, A. V. Kalsin, V. N. Lebedinets, V. I. Ogurtsov, A. V. Pedorenko, N. I. Tereb, V. V. Chmil, and A. I. Yavnyy; Scientific Production Association Tayfun, Obninsk; Kiev State University imeni T. G. Shevchenko; Special Design and Technology Bureau Modul, Vinnitsa Polytechnic Institute; Leningrad State Optical Institute imeni S. I. Vavilov]

[Abstract] The BUFS-1 UV spectrometer carried aboard the third Meteor satellite is designed to measure radiations on the dayside of the Earth in the "measurement" mode (UV solar radiation scattered by the Earth's atmosphere) and in the "calibration" mode (extraatmospheric solar flux measured when the satellite enters the Earth's shadow and exits it). The spectrometer scans at 280-340 nm, with its optical axis at the nadir. In the calibration mode, it measures the flux reflected off the surface of a solar-illuminated photometric body. The instrument uses a dual grating monochromator to isolate narrow spectral intervals. Spectral halfwidth is $\Delta\lambda$ = 1 nm, and field of view is 6°. UV fluxes are registered with FEU-142 photomultipliers whose maximum sensitivity is at 280-290 nm, dropping off at 300-400 nm. Synchronous detection is used to boost the signal-to-noise ratio. The BUFS-1 is a single, sealed unit filled with nitrogen at pressures of 1.0-1.5 atm. It is mounted on an outside platform, which means it works in open space. The unit is powered by an onboard 27-volt system and uses no more than 30 W of power. It is switched on and off via telemetry from Earth or with internal commands. The operation of the unit can be monitored via telemetry, as can the issuance and execution of internal commands, as well as the temperature and pressure within the unit. The metrological certification issued at the Lengingrad State Optical Institute. The results of measurements performed with the BUFS-1 in two space experiments—a 1983 experiment aboard the Meteor-Priroda satellite, involving measurement of the energy distribution in the spectrum of UV solar radiation scattered by Earth; and an experiment aboard the third Meteor satellite, spanning the period from October 1985 to February 1987 and involving measurement of UV radiation scattered by various sectors of the globe—point to the efficiency of the instrument and its accuracy in recovering total ozone content (TOC) in the atmosphere. TOC data obtained by Bangkok, Fresno, Poker Flat, and Barrow ground stations vary by no more than about 5 percent with the satellite data. Figures 4, references 6: 3 Russian, 3 Western.

528.813

Statistical Retrieval of Spectral Luminance Factor of Earth's Surface in Remote Measurements From Space

907Q0055B Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 1, Jan-Feb 90 (manuscript received 15 Jun 88) pp 81-86

[Article by A. N. Valentyuk, Institute of Physics, Byelorussian Academy of Sciences, Mogilev Department]

[Abstract] Retrieval of the spectral luminance factor of the Earth's surface from measurements of the brightness of reflected radiation is usually done by means of representing the transmission function of the atmosphere, which combines the brightness of reflected radiation measured from space and from the surface, and the function calculated on the basis of a globally averaged determinant model of the Earth's atmosphere. However, the optical and meteorological parameters of the atmosphere change statistically in both time and space, which means that the transmission function also changes. Values for the transmission function at any given point in time may vary considerably from the average values. In light of the statistical nature of the changes that take place, the author suggests that statistical approaches are the best means of handling problems involving remote sensing data, and he presents an algorith based on a linear regression model. Maximum relative retrieval error is less than 10 percent. References 6 (Russian).

528.727:629.78

Joint Automated Thematic Processing of High- and Medium-Resolution Satellite Video Data in the Assessment of the Condition of Winter Wheat

907Q0055C Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 1, Jan-Feb 90 (manuscript received 14 Apr 88) pp 103-111

[Article by N. V. Sazonov, A. F. Molchanova, and V. P. Bocharov, All-Union Scientific Research Center AIUS-Agroresursy, Moscow]

[Abstract] Synchronous scanner surveys of the Earth's surface performed by high- and medium-level equipment in a single scanner unit hold a great deal of promise for agriculture. The work reported here examines the elements of a procedure for the joint analysis of data derived with such equipment, as well as the results of experimental efforts in the joint processing of high- and medium-resolution multiband scanner images produced with the Fragment and MSU-S units aboard the Meteor-Priroda satellite. The procedure is based on the analysis of a complex of various kinds of data, including those of the spectral and spatial characteristics of farmlands, their ground and aerial examination, a priori information on the development of crops during the growing

season, cartographic information on farmland boundaries, and the results of a preliminary interpretation of multiband images. The processing itself consists of 11 stages executed "interactively." The authors describe a classifier that uses a blurred description of classes and the relationship of pixels within a class. The procedure offers the advantage of not requiring the conversion of images to a map projection. The authors point out that the procedure enabled them to categorize the condition of winter wheat during the early spring period as "bad, satisfactory, or good" on the basis of phytometric and spectral characteristics. Figures 1, references 12 (Russian).

'Molniya-1' Communications Satellite Launched 11 Aug

LD1308101890 Moscow TASS in English 1012 GMT 13 Aug 90

[Text] Moscow August 13 TASS—A communications satellite was launched by a Molniya booster rocket in the Soviet Union on Saturday, it was officially announced here.

The satellite, Molniya-1, is intended to ensure telephone and telegraph radio communication and to transmit Soviet television programs to points covered by the Orbita television network.

The satellite was placed into a high elliptic orbit with an apogee of 40,634 kilometers in the northern hemisphere and a perigee of 646 kilometers in the southern hemisphere.

The period of the satellite's revolution is 12 hours 16 minutes. The orbit inclination is 62.7 degrees.

Communication via the satellite will be carried out in accordance with a preset program.

'Resurs-F' Earth Resources Satellite Launched 16 Aug

LD1708085990 Moscow TASS International Service in Russian 0810 GMT 17 Aug 90

[Text] Moscow, 17 Aug (TASS)—A routine earth satellite, Resurs-F, was launched in the USSR on 16 August using a Soyuz carrier rocket.

The apparatus installed on the satellite is intended for carrying out multizonal and spectrozonal photography on various scales with the aim of continuing research into the Earth's natural resources in the interests of various sectors of the USSR's national economy, resolving questions of ecology, and international cooperation.

The equipment installed on the satellite is working normally.

When the flight is completed the exposed film will be handed to the Priroda State Research and Production Center of the USSR Chief Directorate of Geodesy and Cartography for processing and for the subsequent distribution of the information obtained to consumers.

'Resurs-F' Satellite Launched 7 Sep

LD0809104790 Moscow PRAVDA in Russian 9 Sep 90 First Edition p 3

[Report: "'Resurs-F' Launched"]

[Text] In the Soviet Union yesterday the latest Resurs-F artificial earth satellite was launched by a Soyuz rocket. On board is equipment designed for vari-scaled [rasnomasshtabnyy], multizonal, and spectrozonal photography aimed at continuing the investigation of the earth's natural resources—in the interests, of course, of various branches of the national economy—and at performing tasks for ecology and international cooperation.

The satellite was placed in orbit with the following parameters:
initial period of revolution—88.8 minutes;
maximum distance from earth's surface (apogee)—267 km;
minimum distance from earth's surface (perigee)—193 km;
orbital inclination—82.6 degrees.

The apparatus installed on the satellite is functioning normally.

On completion of the satellite's flight, the exposed film will be sent to the Priroda State Research and Production Center for processing and subsequent dissemination. By the way, in line with a commercial agreement the Resurs-F satellite also carries scientific equipment from the FRG for conducting biotechnological experiments in conditions of microgravity.

IKI Scientist Criticizes Current Organizational System for Space Programs

907Q0058 Moscow NTR TRIBUNA in Russian
No 23-24, Dec 89 p 4

[Article by L. Ksanfomaliti, doctor of physical and mathematical sciences and chief scientific associate of the Space Research Institute, under the rubric "May I Have the Floor": "Fobos and Voyager: Different Fates"]

[Text] Somewhere in the mid-1970s, when such people as G. N. Babakin and M. V. Keldysh—who did not consider their positions to be too lofty for them to get deeply involved in the scientific and technical problems of space research—had already completed their journeys through life, an alarming syndrome of genuine exclusivism began to spread among the middle levels of management of the Soviet space industry. Certain individuals from certain academy institutions joined in on the exclusivism. Simultaneously, there was a shift in the system of scientific values, and it wasn't for the better. This article is an attempt to tell about certain conditions (about 5 years ago, they would have been considered untypical) under which Soviet space experiments are being prepared and carried out.

The time is long since past when every success in space is greeted with a "Hurrah!" Over the years, very complicated experiments were needed to obtain truly valuable scientific data, and now even whole sets of experiments are needed. It has also turned out that the mechanical application of the concepts of geophysics is ill suited for half of the planets, because they are structured completely differently from Earth. This is seen, for example, in the nature of scientific articles on the American Voyager spacecraft results, which involve not so much the the planets themselves, but rather their satellites, which somewhat resemble the Earth. Soviet scientists are running into this problem to a lesser degree. Our research is limited for the time being to the "Soviet planet," Venus, where we have had a lot of success, and Mars (where there are more failures).

It is curious that, whereas many collectives were dying to get in on the experiments in space in the beginning, that enthusiasm has gradually died down. That "fashionable subject" proved to be a thankless affair and threatened to have more thorns than roses. This was soon felt by many young specialists, most of whom now run from a space experiment as they would from a fire (fortunately, however, "oddballs" are also being encountered now). The favorite pursuit of the young people in science is the science-like play on a computer, a cunning program of calculations that requires a large amount of machine time, and so on. The pragmatists have also found their own "ecological niche." The real treat for them is, without really doing anything, to be attached to an experiment being performed by foreign scientists on a Soviet device and to "fiddle" with the experiment, so to speak. As long as they do not have to set up the apparatus for the experiment! Just what is so dreadful about an experiment?

The physical sciences have always been the most international branch of knowledge. Even during the Fascist era, hardly anyone took the discourses about "Jewish physics" and "Aryan physics" seriously. These days, Soviet and foreign scientists understand one another splendidly, and that despite our poor English (which, at least, we speak) and this inaccessible Russian (which they do not speak). But, in addition to the new scientific concepts, the new data, the brilliant ideas, and the splendid results, there is a side to the life of Soviet experimenters that is hidden from outside eyes.

Take a project that is being put together—Mars-94, for example. Proposals are being discussed, experiments are being screened and their characteristics matched, and results are being taken into consideration—this is the way it's done all over the world, it's all the same. (We could point out the fact that not everything is OK here—a double-dyed scientific exclusivism is issuing from some of our academy authorities. But we are not talking about that here.) The expected expenditures are being determined. Incidentally, there is a lot of talk now about the "wasteful space research." That is very far from the truth, if we are really talking about scientific research. But the launches, the launches... Once, a colleague of mine from a lofty scientific forum, after a recent launch "for the purpose of implementing the program of research on outer space," asked that it be explained to him just what kind of program it is that is "always being implemented and implemented—but is never fully implemented." In fact, the actual expenses are relatively small. For the preparations for the Fobos project, each working person in the USSR spent no more than 2.5 rubles over six years. Incidentally, the traditional scheme was used for Fobos: first, mockups were developed; and then the full-scale vehicle and instruments for engineering purposes; and, finally, three complete sets of such systems for launch. This is a very slow method: the few groups around are capable of manufacturing no more than 1-2 good instruments.

But let us return to our experimenter. The financing has been allocated, and developers and manufacturers of unique equipment that has never before been developed must be found. At the service of Western scientists are the proposals of industrial firms, each proposal more enticing than the next. And it is not just a matter of a company's attempting to snatch its own little piece of the pie—there is also the future prestige ("The company took part in the development of..." will appear in its prospectus). It is the experimenter who bears responsibility for the expenditures, for the selection of the executor, and for the correctness of the proposed designs. But the lion's share of monies—up to 80 percent—will go for testing of the instrument that has been developed, analysis of all its special features, and study of its behavior under conditions similar to those in which it will operate in space.

But, in the life of our experimenter—who receives an extremely modest salary, by the way (the rates for candidates and doctors have not been revised—believe it or not—since 1948)—in his life, dark days are dawning. Even if the money has been allocated, no one needs it (or didn't need it until just recently). Holloa, developers, holloa, manufacturers! All the suitable enterprises have long since been crushed by "defense" departments. And even if it happened that some oddball enthusiasts wanted to take on the work, the main administration's shout would then be heard: so, you have some time and money left over?—Then we will add some things to your schedule. And if that is not enough, it is also possible to bring up the matter of secrecy. The mechanism has been operating faultlessly for many, many years. Under these conditions, one must either develop unique equipment "in the lap" of inefficient academy subsidiary plants or agree to some manufacturer or other (the lower the level, the higher the ambitions). We should mention, parenthetically, that one thing has begun to change somewhat in recent—not even years—but months. Enterprises are displaying a hardly noticeable interest, which is accompanied by a very noticeable inflation of prices. Here are the dynamics of expenditures for similar instruments: 120,000 rubles in 1970, 340,000 in 1975 and 810,000 in 1984. And in 1988, they were already asking 6 million rubles for the same work. The academy sighed deeply and stepped aside.

The preparations for a space experiment or an entire project constantly encounter failures on the part of instrument manufacturers to meet stipulated deadlines. Despite the high staffing levels in the organizations on both sides, the work is done, as a rule, by paltry staffs, to which are attached whole regiments of managers, offices and all kinds of services which make these exaggerated estimates. Regular meetings set up new deadlines, which are routinely not met. The irresponsibility of our developers is enough to drive one to despair. Once, after leaving a regular meeting, a certain "project chief designer" said to me: "Is it worth it to go through all this? There are so many interesting things around us—a car, a granddaughter, a summer house." Frequently, even the experimenters themselves are at fault (there is even said to be a "law" such that the number of "absolutely necessary" changes in the design becomes larger, the closer one gets to the deadline for handing over the work). Eventually, there's no place to retreat to. It becomes necessary to reinforce quickly the groups on both sides. But, alas, luring your own management and another's management to a meeting of the "generals" to solve such matters does not, as a rule, work: they always have matters which are more important (an instrument manufacturer, for example, has problems which are more important than the manufacture of the instrument, while the Space Research Institute has matters which are more important than the space research. It's a theater of the absurd, isn't it?). Whatever happens, neither the first deadlines nor the recent deadlines nor the most recent deadlines are met. Yet, the date for launching a craft to a remote planet cannot be arbitrary—it is governed by celestial mechanics. Suitable "windows" for a launch to, say, Mars come up only once every 2-4 years. Under these conditions, the experimenter almost never succeeds in getting an instrument in the proper form, and there is almost no time left for its examination or even simply for a careful calibration.

The developers of the craft, which includes a large number of systems supplied by other enterprises, are in the same boat. The tardiness of the deliveries doesn't allow enough time for a detailed study of the interaction of the programs, the craft's complicated components and systems, or its automatic and positive-motion control assemblies. Any engineer knows that the mechanical integration of complicated equipment systems does not produce the expected results: labor-intensive, prolonged modification is always needed to achieve the necessary interaction.

Fresh in everyone's mind is the recent failure of the two Fobos craft (although not everyone knows that we did manage to obtain a lot of new scientific data, including some about the satellite Phobos itself). The second craft, which was launched in mid-1988, failed some 10 days short of the main target.

At the same time, Voyager 2 was continuing its flight, which reached Neptune, the last planet on its path, in August of 1989. Were there really no problems with this craft over the entire 12 years of its flight? There were, and how! In 1981, after passing Saturn, the rotating mechanism for the platform on which the scientific instruments were mounted, jammed. In order to understand the cause of the failure, a total of 86 (!) models of the device were quickly manufactured and tested. The problem was found and then eliminated with radio commands. At the time, the craft was 2 billion km from Earth. Back in 1978, the main command receiver failed, and, in the backup unit, as it later turned out, the main automatic frequency control unit had broken down. The craft, it seemed, had gone deaf for good. It did not respond to any commands whatsoever. The specialists were instructed to work up all conceivable variations, and careful analysis made it possible for the control group to find a nearly impossible way out. The functions of the damaged unit are now being performed by the ground computer, which sends via radio a single "note" that is heard by the craft. Thus, within several weeks, they managed to revive the craft, and then, in this mode, it investigated four planets. Occasionally, it again "goes deaf," but they force it to respond, even though it has long since ceased to respond to normal radio signals. The specialists' comprehensive understanding of the operation of the craft plays a large role in the elimination of such defects. Moreover, all its systems have been constructed with a degree of flexibility, which makes it possible to change their structure using radio commands in order to bypass a damaged unit.

Our engineers also know all this. They know, but... Somehow, we never got the word about a collective discussion, with the participation of the Academy of Sciences, of the craft's structure. In general, maximum

favorableness to science seems long to have been a thing of the past. Industry itself decides what science needs and what it does not need, being guided, first and foremost, by its own departmental interests. The backward system for financing scientific projects like Fobos contributes in no small way to that. Scientists need ever increasing volumes of information. Voyager 2 transmitted 21.6 kilobits/sec from remote Uranus and Neptune with a low-power radio transmitter, while Fobos, which was 20 times closer to Earth, transmitted only 16 kilobits/sec, even though its transmitter was considerably more powerful. Are we incapable of doing what they did? Oh no, we are capable. In 1985, we received around 100 kilobits/sec from our Vega craft. That is the tragedy: you cannot get these "petty" problems across to important people.

But now, let us return to our Foboses. Knowing the many specialists who participated in the control of the craft and in its development, I cannot agree with the recent article in PRAVDA that spoke of their incompetence. They are quite competent. It is merely a question of how much time they had to learn to work with this new craft. Even learning to ride a bicycle takes time. But they simply didn't have enough time to study Fobos on the ground. To a large extent, the control of the craft during the flight was by improvisation.

Let us think about the future.

It seems to me that we have both time and money to spare. But think about it—how necessary is it, really, to duplicate launches? A single, thoroughly developed and tested craft with one set of scientific instruments may be much more reliable than two that have been passed through in a slapdash manner at the last moment. Furthermore, we need to reduce sharply the volume of excessive paperwork produced by all kinds of illiterate "representatives." No one is more interested in the reliability of their instruments than are the experimenters. The time spent on paperwork is at the expense of the instruments' quality, for, indeed, the same people handle both. What is more, shouldn't we abandon the practice of manufacturing special, full-scale engineering-prototype assemblies, which eat up a lot of time, but are never brought to perfection. Only a very few units and instruments, in fact, have such a limited useful life that it would be impossible to conduct testing on the actual instruments. And expendable parts (for example, special sensors) can be replaced before the launch. Such a way of doing things would require the delivery of all instruments and units 2-2.5 years prior to the launch. They would become a little bit out of date, but we would have a craft that would be quite reliable. And, finally, an idea which will agitate scientists on both sides of the ocean: why do we need such enormous craft? At one time, it was because of the low level of the technology. But now it is possible to develop extremely lightweight and economical instruments. As a result, even the craft could become smaller and lighter by a factor of about 10.

Leadership of Soviet Space Science Programs Criticized

907Q0108A Moscow IZVESTIYA in Russian
23 May 90 Morning Edition p 3

[Article by Professor I. Podgornyy, doctor of physical and mathematical sciences and recipient of the Lenin Prize: "Ships Are Launched Into Space to the Blaring of Trumpets. But What Are These Launches Giving to Science?"]

[Text] Pointed out in articles devoted to the problems of contemporary science is the enormous harm which is being inflicted on its natural development by the exclusivity and selfish interests of the individual groups and circles which have concentrated administrative power in their own hands. These processes, to a large extent, are identical to those which are typical for our entire society. However, for science, so it seems to me, exclusivity has even more fatal consequences than for industry, for example. The fact is that the violation of continuity, the bureaucratic ban on the right of free intellectual inquiry and the appropriation of the right to the truth, even by competent scientists, are murdering the very essence of true science.

To some it may seem that "Lysenkoism" is no more than a resounding term unearthed in dusty archives and used currently for the sake of rhetoric. If only this were so! "Lysenkoism" is flourishing even at the end of the eighties. It could not be otherwise, inasmuch as it feeds on the same juices as the entire administrative-command system. I am prepared to illustrate this truth using the example of the branch of science closest to me—space research. The space program is traditionally considered to be one of our most thriving fields. This is precisely why the analysis of the situation in it seems most significant.

In 1973, an energetic and ambitious scientist, R.Z. Sagdeyev, was appointed director of the USSR Academy of Sciences' Space Research Institute. At that time, he was one of the youngest of our academicians. He was full of his own ideas and this is good. But it is bad when something new leads to the disintegration of what has already been achieved. The new administration declared the many promising directions, where the USSR was a recognized leader, anachronisms. what was to replace them? Carried out was the Soviet-French Araks experiment, which turned out to be a replication, and not too successful, of the old experiments of an American, J. Winkler. Even now, none of the specialists can answer the main question: what part of the electron beam reached the earth's atmosphere? But science is a shady business. Public opinion is much more important for the semblance of success. So it was that not one of our previous and much more successful experiments was so widely presented in the press. True, there is nothing wrong with publicity in itself. But why, if the selected direction was really so promising, did they soon forget about Araks and jump to new themes?

In 1971, at the International Assembly of Aeronomy and Geomagnetism, the USSR announced an extremely promising program: research on near-earth space using three Prognoz satellites flying simultaneously, which were called then by foreign scientists the "Russian Troyka." The title is beautiful, but that is not the point. The planned experiment would make it possible to approach the investigation of the magnetosphere in a qualitatively new manner. After R.Z. Sagdeyev's arrival at the institute, the transformed program was called Interbol, but the launch deadlines were now put off not for years, but nearly for 2 decades. The project head, A.A. Galeyev, put a lot of effort into public affairs—this is a sure guarantee of successful advancement upward on the scientific-administrative ladder—while the project itself, in essence, came to a standstill. Meanwhile, the idea caught on abroad—at the present time, several variations of this project have been carried out successfully in the USA and Western Europe. It is difficult to exaggerate the importance of these achievements for science.

The consolation we could find is quite traditional. Both during the development of an artificial comet and during the first rendezvous with a real comet, the foreign scientists used the laboratory model developed in the USSR Academy of Sciences' Space Research Institute. The basis for these experiments was developed in the institute back in 1967 on the initiative of Academician G.I. Petrov. It would seem that this is a golden asset of our science and that it needs to be taken care of and used to obtain new results. But really, can the achievements of others be grounds for a monopolized science? In April of 1987, there occurred the barbaric, I would not pick any other word, destruction of these unique devices, which are known throughout the entire world. The equipment, which was on the list of the USSR Academy of Sciences, was destroyed by order of the department head, A.A. Galeyev and the institute's director did not hinder this in any way.

A misfortune of our science is the fact that the right to one's own opinion and, thus, the opportunity to conduct one's own line of research more or less unhindered, is granted only to those scientists who have made it onto the nomenclature and occupy adequately high official rungs. And this is why few scientists will turn up who would not glance at the bureaucratic pyramid with longing and decline a flattering appointment. Yes, a wise leader is a great boon to science. But really, can a whirlwind of personnel reshuffling occur without affecting the successful scientific work and the healthy atmosphere in the collective? Over the last few years, already more than 10 deputy institute directors have been replaced in the Space Research Institute, not to mention the leaders of lesser rank. Recently, A.A. Galeyev became the director and his deputy, Candidate of Sciences V.M. Balebanov, is curing many problems, include scientific one's as well. In such a situation, can the leadership's scientific competence remain at the proper level?

One of the most significant events of recent years was the launching in 1981 of the Soviet-Bulgarian Interkosmos-Bolgariya-1300 satellite. The manner of operating with this project was a special one in the institute. L.I. Brezhnev was personally interested in the project and he even phoned the launch site from the Crimea where he was resting with T. Zhivkov. Difficulties were solved instantly and, from the first meeting of the specialists to the launching of the craft, a little more than a year passed. The IKB-1300 satellite served science well and obtained quite a few unique results. But then the political situation changed and the still operating craft, which had not completed an important experiment, was turned off by order of V.M. Balebanov and ceased active existence. None of the project's participants, including the Bulgarian scientists, was informed about this extremely strange decision. Less than 10 percent of the obtained data has been subjected to scientific processing. Why bother with science when the leadership of the Space Research Institute already saw another efficient project which promised quite a few honors?..

The Vega project, the flight to Halley's Comet of two space vehicles, was written up so much in the press that it is likely that even little old ladies and preschoolers had heard a lot about it. But the specialists knew also the other side of this noisy epic. The leaders of the Space Research Institute, having decided to head up a scientific program of research, had never dealt with these problems before and none of the prominent Soviet comet scientists was involved in the work. Apparently, they did not want to share the glory. However, this led to a lack of contacts with certain venerable foreign specialists who preferred not to risk having anything to do with little known companions.

Our industry has given the USSR Academy of Sciences' Space Research Institute two giants with a usable weight of 250 kg for each. Difficulties arose only with the scientific instruments. The project's scientific adviser, Academician R.Z.Sagdeyev, decided to manufacture practically all the equipment abroad. And even though there were quite a few promising suggestions from our scientists, they were rejected without discussion. Our domestic instrument making industry was given the red light. Were the Western instruments really that good? Nothing of the sort—a number of them turned out to be useless. The ING mass spectrometers from the FRG, for example, failed on both Vega craft, ruining the most important experiment for the study of the chemical and isotopic composition of the near-comet plasma. There are many such examples.

But the main thing is not the individual omissions. In my view, it is impossible to overrate the importance of instrument making for the progress of the space program—it is precisely this which determines the capabilities of the space programs and the prospects for the entire sector. In the Vega project, the Soviet side invested impressive assets in the development of spaceships, which had already adequately been mastered

previously, while, in instrument making, that is, precisely where it was necessary to achieve progress, we remained essentially in the same spot. Thus, the Vega project shaped up as a free trip to the comet for Western instruments, which were by far not of the best quality.

But, perhaps, that was the first, even if somewhat uncertain, step in the field of cometary physics taken in the USSR Academy of Sciences' Space Research Institute? This page of research in the institute was closed out on that single flight. And this is why the impression is being created that it was not science as such which was the main goal of the Vega project. In fact, state awards, prizes and honorary titles rained down on the project's supervisors as if from a cornucopia. Space science in the USA, Europe and Japan taken all together for the entire time of its existence has never known such a quantity of medals, yet, indeed, the obtained results turned out to be extremely modest.

After the completion of the Vega mission, Academician R.Z. Sagdeyev, with enviable energy, set about promoting in the various publications a new gigantic project—a manned flight to Mars. The approximate cost of such a flight is around 100 billion dollars. If you take into account the fact that the annual budget for the Soviet space program is currently around 7 billion rubles and an increase in it is hardly expected in the next few years, then it is possible to assume that the Mars project will "close out" all the other directions of the space program.

The first step has been taken—the flight of the "Phobos" vehicles to the Martian satellite. It is not necessary to recall the deplorable results of this mission. Both craft were lost prematurely and the results transmitted by them do not justify the bills paid. The scientific data file is large but there can be no talk of a key innovation. Who is at fault for the mission's failure? In complete conformity with the spirit of exclusivity, it is necessary to deflect criticism away from one's own department. The institute's leadership rained down sharp criticism on industry, blaming it for all the failures. Well, the designers did not earn a grade of "excellent," but did the project's scientific adviser sufficiently actively assist in the development of the vehicles, participate in the solving of problems during the course of the flight and spend sleepless nights at the control panel? It is no accident that R.Z. Sagdeyev leaves these claims of the industry's representatives unanswered. It is true, he was not obliged to do this. But M.V. Keldysh was also not obliged to do this, but he did. Perhaps, this is also because, previously, our space science did not know such distressing blunders. However, there are no grounds for doubting that, in the event of success, the project's scientific leadership would not remain on the sidelines and would skim off all the cream.

Generally speaking, the scenario of the last few missions compels one to doubt as to why NPO imeni Lavochkin, where the space vehicles are made, in principle, needs to work with the USSR Academy of Sciences' Space Research Institute, with its orientation toward foreign researchers and foreign instrument making. It would be simpler and more efficient to organize its own international commercial department and sign contracts itself...

What about today? In September of 1989, the Aktivnyy craft was launched. And again with publicity still on the highest level—for the first time, foreign journalists were permitted to go to the northern launch site, along with their Soviet colleagues, who aspired to the title of cosmonaut. Concealed behind the festive screen, however, was a somewhat different picture. The launch deadlines had been postponed for nearly 3 years, but the craft had not been brought up to current standards. It has been flying for several months now, but it has been impossible to make it fully operational.

It is simply absurd to talk about some kind of policy or long-term program of research on outer space by our automatic craft. It is possible to assume that some kind of fashionable project will be put forward, one gleaned from a foreign article, with an advantageous situation, and again, the search for the instruments of others will begin. As a result of the inconsistency and the bouncing from side to side on a number of key problems of the USSR space program, there are no results at all. The gaps in the most important fields of space science are being aggravated by the division of the Space Research Institute's scientists into "our own" and "others." Using all the possible bureaucratic tricks, conditions are being created for the "others," which preclude fruitful scientific work. As a result, left without work was a collective of astrophysicists, with worldwide prestige, who came to the Space Research Institute along with their brilliant leader, I.S. Shklovskiy, a corresponding member of the USSR Academy of Sciences. The department of Academician G.I. Petrov was forced to take leave of the institute 3 years ago. Recently, another prominent scientist left the institute together with his department—N.S. Kardashev, a corresponding member of the USSR Academy of Sciences.

It would be good if the parting with the Space Research Institute had been caused by differences of a purely scientific nature. But the monopolists "crush" opponents without listening to their arguments. Several years ago, for example, the group for the study of cosmic rays was eliminated in the Space Research Institute. Currently, this subject, which had fallen into disgrace in former times, has been rehabilitated and turned over to R.A. Syunyayev, who is one of the few people in the institute who is obtaining highly promising results. But what was the reason back then for the previous persecutions?

Yes, the situation with space research on "the sinful Earth" is distressing. Does this disturb the sector's leaders? Protected by high ranks, to which they prudently aspired almost with greater persistence than directly for results valuable for science, they recognize their invulnerability. The recent attacks on the space budget were repulsed with ease but, unfortunately, none

of the critics attempted to go deep into the problem. Space science, without a doubt, is important and will not be subject to curtailment. But this does not get rid of the question of how its leaders dispose of the large assets which are entrusted to them by society. The virus of "Lysenkoism," as D.S. Likhachev puts it, is tenacious. I would add that even its external manifestations are quite traditional: the blaring of the trumpets and the abundant promises—and after a routine failure, the skillful masking of the actual state of things. Inasmuch as, for a number of positions, the space program is still among the leaders, there is every reason to believe that the picture is scarcely brighter in other fields of science. The prescription for the prolonged ailment must be sought by our entire society and it must be found as quickly as possible.

Value of 'Mir' Space Station Program Questioned

907Q0154A Moscow MOSCOW NEWS in English No 30, 5-12 Aug 90 p 15

[Article by Boris Olesyuk, Flight Control Center: "Space Exploration—A Wasteful and Inefficient Effort"]

[Text] The station Mir, the centre-piece of today's space complex, was put into orbit February 20, 1986. Plans called for five specialized modules to be docked to Mir to conduct a variety of experiments and research. The original idea was that the station should be constantly manned.

This did not happen, although the station has generally proved to be stable and viable. The complex assembled in orbit today weighs an impressive 80 tons. Mir was manned by many crews, some of whose members were from other countries, and has conducted a vast research programme. A big share of work was done by A. Viktorenko and A. Serebrov who, in less than a month, made five space walks to test the improved suits and what they called "space motobikes."

But to claim that all has been going well on board Mir, would not be telling the truth. Attractive ideas are one thing, their implementation quite another. Looking at it without the recent euphoria, one can see serious errors in the implementation of this complex space programme. A number of problems developed right at the outset. Some of them have persisted till this day.

Some of the space research secrecy has been penetrated by glosnost. Now it's clear that secrecy has mainly served to hide errors and failures from the general public. Some of the once top secret figures on space research funds have now been published. We now know that 220 million roubles have been earmarked for this year for manned missions—a sum that calls for serious explanation. But how much does the Mir station cost our society? What is the cost of this or that module docked to it? That we still don't know. These are not idle questions, considering that the main objective—to assemble the whole space complex—has not been reached. For example, the second module was put into orbit two years behind schedule. The onboard systems have been in operation 65 per cent of their useful time, while Mir's warranty period ends in 1992. If things continue at this rate, how can the programme be carried through?

The project had a promising start. The station was put into orbit in February 1986 and March 15 saw the first Soyuz T-15 with L. Kizim and V. Solovyov link up with it. Things were really humming on board Mir. But then followed delays of the launch of the first module and that delayed the schedule of manned flights and messed up the composition of the crews. The programme lost momentum. On one occasion the station remained unmanned for more than six months.

Things seemed to have been put back to normal with the arrival on Mir of Yu. Romanenko and A. Alexandrov and the long-awaited first module for astrophysical research, Kvant, was docked to it. The crew was then succeeded by V. Titov and M. Manarov, who worked on board a whole year. The schedule was then messed up again and no crews were sent for some time. Why? Because of the holdup with the launch of the second module. The Khrunichev factory that manufactured it was behind schedule because their suppliers of electronic gear had failed to honour their commitment.

Both Kvant modules caused quite a headache for ground control. In both launches the onboard computers detected errors in calculations and shut off the steering system during the closing stage of the rendezvous.

It would be naive to suppose that the equipment used on board Mir is state-of-the-art and operates without hitches. Sorry to say it has the same drawbacks our technology generally has. Mir has as many as seven computers, each module has its own computer—a whole orbital computing centre. But the weakest link is the computer that controls the powered gyroscopes of orientation and stabilization. Wouldn't it be better to have less computers, but more powerful, reliable ones?

Pride of place on board Kvant-2 is taken by a video spectrum package with a remote control platform and the multizonal photographic camera MKF-6MA manufactured in Czechoslovakia and the GDR. The module has remained docked to Mir for more than six months, but the equipment has not even been tested yet. Despite all logic and common sense, only two cosmonauts work on this huge station. The most sensible number of cosmonauts is six, working in two shifts so as not to use up too much electric power. But there is no way of bringing more cosmonauts because there is no free docking unit left on Mir, while the stern part of the Kvant is designed to take only supply ships of the Progress type. Another paradox is that with efficient use of all the equipment hundreds of kilos of products can be produced in weightlessness but there is no way of taking them back to earth. Only the sixth, modernized, version of the Progress supply ship has a descent module. A vicious circle.

I'm not exaggerating. While flight controllers do not always do their best, neither do the cosmonauts. The

result is that the station's potential is only being used by fifty per cent at best. Unfortunately, the huge funds paid out for manned missions don't produce returns.

The sixth crew, currently on board the station, was expected to net 25 million in profits. This was mentioned, among other people, by O. N. Shishkin, Minister of General Machine-Building, when he spoke to journalists at the Baikonur cosmodrome last February shortly before the launching of the Soyuz TM-9 ship. The technological module has four plants to produce semiconductors and medicines. Economists thought that the cost of sending cosmonauts up there would be 80 million roubles and the cost of the products they would manufacture in the Kristall module would be 105 million. The net profit would be... That's right, but only on paper. This would have been the case had Kristall been launched in late March. After three delays the module was finally launched and docked to the complex on June 10.

The delays were caused by failure on board the station in the system of the powered gyrostabilizers. The cosmonauts replaced the onboard computer, modified its programme. But it took a long time to make the powered gyros of the Kvant and the onboard computer work in unison. The technical difficulties were finally eliminated. The Kristall was launched successfully but then a hitch developed. One of the smaller thrust engines in Kristall failed before the sixth and last manoeuvre and the computer cut off the steering system. The rendezvous procedure had to be repeated relying on standby equipment and that took another four days.

In short, the cosmonauts have practically no time left in which to carry out the programme. They are to go outside their ship to repair the ship's insulation. Flight Control have decided to extend the flight ten days so that the crew can at last bring some results back to earth. But I think what has been lost and wasted can never be compensated for.

EDITOR'S NOTE

B. Olesyuk's article, which is on the whole interesting and full of facts, does not, I think, answer the question he raises about Soviet space achievements. The greatest achievement is that this country is once more ahead of other countries. No country including the United States has anything like our Mir orbital complex. Not long ago, this statement alone would have been more than enough to banish any doubts about the hundreds of millions of roubles spent on it. Today we question not only the exigency of the project, but also whether it was moral to undertake it. Brezhnev propaganda of course needed "outstanding victories in space" and greater numbers of "space heroes" in the same way it needed to divert northern rivers to the south and other great projects. That was a practice polished over the decades. No wonder the system is hard to stop. While it uses old propaganda ploys to justify the project, it alleges that it will benefit society, enormously.

Today the United States is mercilessly cutting back on overambitious space projects and it's high time we too decided whether it is wise to continue manned space flights at great cost yet small returns. Wouldn't it be best at this stage to carry out a conversion of our space research and limit our efforts to programmes that bring undoubted benefit: communication and navigation satellites, etc.?

Leonard Nikishin, MN science desk

State Commission Deputy Chairman Defends Space Spending

907Q0070 Moscow EKONOMIKA I ZHIZN in Russian No 14, Apr 90 p 8

[Interview with State Commission Deputy Chairman Igor Ivanovich Kurinnyy, by EKONOMIKA I ZHIZN special correspondent N. Tarasenko, Baykonur and Moscow, under the rubric "Timely Interview": "The Economics of Space as Measured on the Ground: Our Special Correspondent Talks with State Commission Deputy Chairman I. Kurinnyy"]

[Text] [Tarasenko] Igor Ivanovich, first a few words about yourself. If it is not a secret, what do you do in the state commission?

[Kurinnyy] I am a political worker by profession. I graduated from the Military-Political Academy imeni V. I. Lenin. I have been associated with the space program for more than 20 years. As a state commission member, I am responsible for the work of a large contingent of specialists at the Baykonur Cosmodrome. There are cosmonauts, but we are "geonauts." From the ground, we ensure the launching of the launch vehicle and the successful performance of space flights.

[Tarasenko] Does that mean that you can judge the economics of space from solid ground positions? Then it will be interesting to find out your opinion regarding the calls resounding more and more frequently in society for reduced financing or even for completely curtailing space research.

[Kurinnyy] There was a time when Western cartoonists depicted our country about like this: speeding along in a Chevrolet is America, while trailing far behind on an old nag is the USSR. So now, if we stop space research, it's possible that, once again, we will have to drag ourselves along in a cart. And the matter here has nothing to do with the notorious slogan—catch up with and surpass America. In space, in a number of areas, it is the United States who is chasing us.

Immense sums of money have been invested in space. But only now are they beginning to yield a return. Stopping space research would mean throwing billions of rubles down the drain. Working in orbit today is a crew consisting of Anatoliy Solovyev and Aleksandr Balandin. They are the first ones in the manned space program to

shift to cost recovery. The fulfillment of the planned program should produce a profit of 25 million rubles.

Space exerts an enormous amount of influence on the development of scientific-technical progress. Thus, for example, thanks to the birth of the Energiya system with the reusable Buran, new types of materials and alloys have appeared. The many sectors of the national economy have received around 600 suggestions on the introduction of the latest technologies and designs.

We must not forget that the AN-225 (Mriya) general-purpose aircraft, which is intended for the transportation of large-size cargoes, made its appearance thanks to Energiya and Buran. Today, it is being used quite a bit in the national economy. With the start of series production, the AN-225 will not only deliver components of rocket-and-space systems to the cosmodrome, but will also transfer by air derricks, fractionating towers, and other unique cargoes weighing as much as 250 tons. At the same time, the cost of transporting cargoes using the AN-225 is 30 percent lower than with its predecessor, Ruslan (the AN-124).

Invaluable is the contribution of the space program to the development of the basic sciences. Space equipment has enabled specialists to obtain photographs of many objects of the solar system and to reach the surfaces of the Moon, Mars and Venus. The results obtained have produced a real revolution in astronomy. In 30 years, man has learned more about the solar system than in all our pervious history. The economic impact of the basic research is complicated and, at times, even impossible to express in rubles. But this research is of lasting importance to man's knowledge of the world around him and the processes which are taking place in it.

That is precisely why I view as a most profound error the opinion of those who declare that we should, in their words, first feed the people and solve all the social problems and then concern ourselves with space. A year of "idle time" in the space program might throw us back a decade in tersm of scientific and technical development.

[Tarasenko] Yes, but even USSR People's Deputies are coming forward with suggestions to cut spending for space. Yet one hears nothing of well-reasoned objections on this score from the cosmonaut-parliamentarians.

[Kurinnyy] I asked them about this. They say it is difficult to get to the rostrum. I do not think this is entirely true. Yet the cosmonaut-deputies really have something to say! In fact, recently, at the initiative of those deputies, many of our legislators visited Zvezdnyy Gorodok. And do you know what—the opinion of many of them regarding the advisability of the expenditures for space literally changed before my very eyes.

[Tarasenko] In a little more than three decades, our space program has traversed the path from the development of the earth's first artificial satellite to the launching of the Energiya-Buran system. And all these years, we have heard practically one and the same set of standard reports: the equipment is working normally, the cosmonauts feel fine, the mission program has been successfully completed. Not a word about the economics of space. Igor Ivanovich, has not the lack of information given rise to a state of "raging incompetence"?

[Kurinnyy] I do not think you can discount that reason. There have been more than enough conversations about the supposedly fantastic expenditures for space. But is this really so? The manufacture of a launch vehicle costs 2-3 million rubles, on the average. The Soyuz spacecraft costs 7-8 million rubles. That is, their overall cost is comparable to the cost of a modern passenger plane. And from year to year, the cost of space equipment is decreasing, since we have its line production set up.

In our country, data has not been published about the cost of putting a payload into space, but there are indices from around the world with which our expenditures are comparable. Just what are they? The cost of placing a single kilogram of a payload into a near-earth orbit has been reduced from $80,000 (in 1958) to $5,000 at the present time.

Recently, our economists have been alluding more and more frequently to the USA and Japan and other highly developed countries, saying, there they know the monetary figures. So let us compare our expenditures and theirs. The U.S. space budget for last year looked like this: military space—$22.8 billion, civilian space—$3 billion, the shuttle program—$3 billion, other research—$800 million. Altogether—$29.6 billion. Our country's overall expenditures for space amounted to 6.9 billion rubles last year: economic and scientific space—1.7 billion, military space—3.9 billion, the reusable Buran system—1.3 billion rubles.

The Japanese are not scrimping on money for space. Last year, the (NASDA [National Space Development Agency]) budget reached 126 billion yen, and the increase for this year amounted to 9 percent—more than for any other department of that country.

Recently, there have been particularly stormy discussions over the appropriateness of the development of the reusable Buran system. Over the course of 13 years, 14 billion rubles have been invested in its development and construction, but a large return is also expected.

[Tarasenko] Igor Ivanovich, a "large return"—these, you will forgive me, are empty words for economists. Could you not give some specific examples of the practical return from space research?

[Kurinnyy] Let us take that same Energiya-Buran system. According to the specialists' calculations, it is expected that, by the year 2000, all the expenditures on its development will already have been recouped. There are quite a few interesting proposals for the efficient use of the Energiya launch vehicle. For example, the plan developed for placing into a geostationary orbit a new generation of 18-ton communications satellites will

make it possible to solve the problem of establishing telephone communications throughout the country. This projects' cost is approximately 6 billion rubles. If telephone communications were established using traditional methods, the monies required would be 10 times greater.

[Tarasenko] But this is still just a plan...

[Kurinnyy] I have already mentioned the use of individual developments from the Energiya-Buran space system in the national economy. I can add that more than 80 types of new materials have been obtained in the course of the realization of thisunique program, and those materials will provide a qualitative boost in the development of machine building. The automatic landing system tested during the Buran's first flight is of enormous importance to passenger and transport aviation. The approved methods for non-destructive inspection will find an application in many sectors of industry. Space technology has made it possible to improve substantially aluminum and high-temperature alloys and ceramic materials. And this is just a small portion of the specific return from the space program. And, indeed, space is still also in "work overalls."

The first Soviet Molniya-1 communications satellite was placed into orbit in 1965, and, since that time, they have been launched on a regular basis. Thanks to that, today, more than 100 large space communications stations are ensuring the reception of television and radio programs. Telephone, telegraph and facsimile communications and the transmission of the mats for printing newspapers are being carried out via them, as well as via the Raduga communications satellites. The merits of space communications include, first of all, a high rate of efficiency. The transmission of a newspaper page from Moscow to Khabarovsk over an ordinary channel takes 22 minutes. With the aid of space, three minutes are needed for this operation. The texts of newspapers arrive in Tashkent from Moscow in all of 2.5 minutes. According to the USSR Ministry of Communications' data, the annual economic impact of the use of space communications amounts to around 550 million rubles.

Geologists, agricultural workers and fishermen are employing space-derived information more and more. For example, cosmonauts Leonid Popov and Valeriy Ryumin transmitted to fishermen the coordinates of fishing regions around 200 times during the 185-day flight. The overall economic impact in this field is estimated to be 200 million rubles annually.

One of the most important areas of the practical use of the manned space program is the testing and organization of space-based manufacturing processes. The production in weightlessness of special semiconductor crystals is becoming particularly important. Tons of such materials are needed annually. A. Solovyev and A. Balandin's mission is supposed to begin, for all practical purposes, the industrial production of crystals. Unique instruments will be developed based on them.

Biotechnology experiments and research occupy a large place in the cosmonauts' work in orbit. Pharmacologists and specialists in agriculture, the food industry, bioorganic chemistry, and genetic engineering are interested in the production of biologically pure substances... Many foreign companies have already signed contracts for obtaining protein preparations from the Mir station.

Space technologies have a great future. By 1995, according to the scientists' calculations, Soviet cosmonauts will be able to produce in orbit 3-5 billion rubles worth of semiconductors and medicinal preparations.

[Tarasenko] Igor Ivanovich, I recently came across the following information: according to American calculations, $1 spent on space will, with the skillful use of what is achieved, produce $7 in profits. Are we capable of such profits?

[Kurinnyy] I cannot makes a specific evaluation of that—that is a matter for the economists. But I know this for certain: the people associated with space are doing everything possible to see that each invested ruble produces a substantial return. That is precisely why, even last year at the air show in Le Bourget, rates were announced for foreign clients for satellite launches by Soviet launch vehicles. The first contracts have already been concluded. The Americans have committed themselves to paying $54 million for the placement into near-earth orbit of their Satrack Satellites by Soviet Proton launch vehicles.

Glavkosmos has also announced the cost for delivering cargoes to the Mir orbital station—$20,000 per kilogram, and $30,000 per kilogram if the cargo is returned to the ground. Participation by foreign cosmonauts in experiments in orbit has been priced at $120,000 per hour of work. Even now, cosmonauts from England, Austria and other countries are already undergoing training at Zvezdnyy Gorodok.

Yes, there are many disputes today about whether or not the development of the space program should be continued. Thus, at one time, Yuriy Alekseyevich Gagarin wrote in his diary: "The discussions have begun about whether the next flight is necessary? We need the flight. And not just one. We need to make more flights and to acquire experience and knowledge for future, more complicated, longer flights." The remarkable words of a great man. And I am simply certain that the Soviet space program will eventually show us what it can really do.

Benefits to Economy From Space Program Lauded

907Q0078 Moscow SOVETSKAYA ROSSIYA in Russian 12 Apr 90 Second Edition p 4

[Article by G. Glabay, under the rubric "Cost-Accounting Orbit": "Buran's Conversion"]

[Text] For many years, in marking the Space Program Day, we have talked about our splendid victories in the conquest of the universe, sensing at the same time our

own participation in them. But the secretiveness surrounding space topics hindered the objective evaluation of the situation in the Soviet space program, which was changing and, as it now turns out, not always for the best. Today finally, the possibility exists for the expression of sincere opinions about the development of this pivotal sector of scientific and technical progress.

In order to begin such a discussion, let us turn to something which is well known to everyone—the Kosmos [Space] Pavilion at the Exhibition of USSR National Economic Achievements. Not long ago, it was one of the most visited pavilions at the exhibition. Oral presentations and meetings with cosmonauts were held in it. But today? What do you think—is it possible to see here, for example, the Buran spacecraft or the Energiya launch vehicle? No. In order to get acquainted today with the latest models of our space equipment, it seems that you have to go abroad, where the USSR Academy of Sciences and USSR Glavkosmos are organizing its display. The Lunokhod lunar rover, the Foton satellite, the Mir orbital station, the Kvant module and the Progress cargo ship are also absent from the pavilion's exposition. Also not here are the launch vehicles which are capable of placing the most diverse loads into orbit.

The Kosmos Pavilion building was constructed many years ago. Today it is in sad shape. The repair of the halls, done seven years ago, did not change the situation. In summer, rain inundates the exhibits and, in winter, snow covers them. The exhibition's largest pavilion is not heated during the wintertime.

Is this unenviable picture at the exhibition really an accident, or does it just reflect the trends in society's attitude toward the problems of space? Let us attempt to answer this question. In 1989, some 1.7 billion rubles were spent for national economic and scientific space research, while around 4 billion rubles were spent on military needs in space. This year, those sums have been reduced by 10 percent. And certain members of the Supreme Soviet are demanding even greater cuts in the "space" budget, considering it to be an unbearable burden on the state treasury. But here are some data for comparison: as it turns out, the upkeep of personal automobiles, according to modest estimates, costs each citizen of the country 36 rubles a year; space research costs only 6 rubles. Yet, the latter is a powerful stimulant for scientific and technical progress: if we put the brakes on in the space program, we will lag behind even more in other sectors, and that means even in the economic system as well.

In addition to the "personal vehicles," there are also other significant financial outlays which substantially exceed the expenditures for space. It is not possible to reduce yearly expenditures on the order of 40 billion rubles for the upkeep of the administrative apparatus. The losses of agricultural output in 1988 alone, according to various estimates, amounted to 47-95 billion rubles, which exceeds the American space budget for last year. All the operations necessary for the development of petroleum, gas, and chemical complexes in Tyumen Oblast will cost 90-100 billion rubles. Even with a delay in the start-up of just one of them—for example, the Tobolsk complex—it will turn out to be necessary for the country to repay Western loans to the tune of $287 million. And that with our current deficits!

Why is it so necessary to show that the expenditures for the space program are justified? Nowhere else in the world, even in the developing countries, does such a question arise. With regards to the developed countries, the American space budget for 1989 amounted to $29.6 billion; in France, the space budget was 7.7 billion francs; in West Germany, 35 million marks; and in Italy, 800 billion lira. Great Britain's appropriations for 1987-1988 amounted to 120.9 million pounds sterling. Sweden, Austria, Finland and Israel also have their own space programs...

There is no doubt that, with the present state of our economic system, reasonable principles are needed. There is also no doubt that the return from the monies invested in the space program must be increased. Unfortunately, there are few such examples. This, most likely, also causes the people's irritation toward the comparatively small expenditures which are going for space in our country. With even greater probability, it may be assumed that the commercialization of the Soviet space industry will help, first, to eliminate that irritation and, second, to produce large revenues.

Take, for example, the domestic launch vehicles. According to the statistics, their reliability is the best in the world. However, they have not been widely used for launching foreign satellites. Here it is not a matter of inadequate competitive ability, but rather, a matter of the artificial limitations set by the Western countries. Yet, the launch of just one communications satellite into a geostationary orbit would bring our treasury $80 million. Currently, there are around 150 such satellites in the world market. It is only necessary to be able to come to an agreement, as was done in March of 1988—prior to the launch of the Indian satellite, the USSR made $7.5 million. Today, international cooperation in this direction is somewhat difficult, but it is increasing. For example, a contract with the American company, Energetic Satellite Corporation, promises to bring in $54 million.

We are also beginning to consider the money that is in a sphere such as the training of foreign citizens for space flight aboard Soviet equipment. The desire to participate in joint flights has been expressed by France, Japan and Great Britain. Representatives from Austria, the FRG and Italy may be added to this list.

Also becoming a reality are long-term programs of cooperation in the field of manned flights. An example of this is the signing in December of last year in Moscow of a 10-year agreement with France, according to which it is proposed that five joint missions take place on board the

Soviet Mir orbiting complex. The first flight is planned for 1992. Its contribution to our economic system is $12 million.

Here I would like to ask the hotheads: "Just what are we supposed to destroy first now? The ties toward which the Soviet space program has been moving for many long years? Our own scientific programs?.." Common sense prompts that neither should be destroyed.

A few words about the connection between scientific and technical progress and the developments for space. One often hears today that the latter give nothing to the national economy. Such statements, as a rule, are dictated by a desire to improve the well-being of the people. However, even the best of intentions, if they are not supported by a profound knowledge of the subject, are dangerous. A negative attitude toward space research involuntarily leads to the disintegration, unbeknownst to the majority of people, of a powerful stimulant for scientific and technical progress.

In order to understand what kind of contribution the space program makes to the national economy, let us turn just to the developments associated with the Energiya-Buran system. Its developers have made 581 suggestions to other sectors of industry concerning the transfer of the latest technologies, materials and designs.

Let us take a look at some examples. A method for predicting the critical state of a part may already find widespread application in electrical engineering, the automotive industry, shipbuilding—anywhere where it is necessary to ensure the serviceability and durability of instruments and machines. Measuring equipment may be used in the chemical, gas and oil-refining industries. High-quality sealing compounds with guaranteed explosion-resistant protection will find application in mines and in the chemical industry; while high-temperature polymer composites, adhesives and synthetic felts will find application in the automotive and machine-tool industries and in medicine, agriculture and radio engineering. Tile material makes for a high-quality heat insulation for high-temperature furnaces. Its use makes it possible to have electric energy savings of up to 30-50 percent.

Just these listed examples cannot completely characterize all the accrued potential. Indeed, for the Buran orbital craft, 48 new materials have been developed, many of which, in terms of various parameters, are superior to what exists not only here at home, but also abroad.

Another question is, where can all this be seen and then be used? Nowhere! Not counting, of course, the sector exhibition of the Kompozit Scientific Production Association, which, by the way, is not open to everyone, and the individual articles in the newspapers and magazines. But even this skimpy amount of information has already stirred up the professional interest of, among others, collectives at the Novolipetsk Metallurgical Combine and oil refining industry specialists in Kuybyshev Oblast. If an intelligent intermediary were to appear on the scene, then it could be expected that there would be the most widespread transfer of the space program's developments to the national economy. And where something is introduced, there is a profound economic impact. It is just that such an intermediary has yet to appear.

But then, there is something else. Conversion has recently become fashionable. And again, with hope and tender emotion, we are waiting for a social and economic miracle, having forgotten that there are already dozens of special ministries for the turning out civilian products.

We fall to thinking about how, by 1995, more than 60 percent of the defense complex's products, as a result of accelerated conversion, will be civilian! Accelerated development again? But are we not trying to change-over an economic system which has reached enormous dimensions to peaceful tracks! It is necessary not only to define clearly the key factors of conversion, but also to be able to employ them well. Indeed, the retraining of the current labor collectives to develop and produce new products will involuntarily lead to and is already leading to a drop in the volume of production and in labor productivity and to a loss of specialists.

Who, for example, will say what and how much needs to be produced today, let alone tomorrow? How many refigerators, radios, washing machines or whatever are needed to saturate the domestic market? What goods should be given preference? Where is the unified, balanced, integrated conversion program? Now each enterprise behaves according to its own production structure. Some are establishing joint trade, some are undertaking the development of expensive and cumbersome systems for which, it is obvious even now, there will not be much demand, and some, without further ado, have simply switched over to the production of barrels and shovels...

It is probably possible to compel the Ministry of General Machine Building to also make automated lines for processing agricultural products. But who will assure us that degradation and a "brain" drain will not set in here? When, after some time, we again turn to space matters, then we will suddenly see that the years of cooperation among the scientific and production collectives have disintegrated and the leading positions held by our domestic space program forfeited. Dozens of years will pass and we will be criticized not for diverting the rivers, but rather, for the fact that we did a stupid thing in allowing ourselves to be led by those who, without adequate grounds, call for the curtailment of the space programs.

Obviously, it is necessary today to talk not about the conversion of enterprises, but rather, about the conversion of the results of space research and technologies.

It is true that interdepartmentalism and the secretiveness that attaches to space developments are a "rich" medium in which it is impossible to understand how the strategy for space development is determined and to

whom to appeal when one or another problem is seen, and there are quite a few of them which have accumulated in our "space" home. Is it not because of this responsibility for the sector among everyone and not just one person in particular that the prestige of the Soviet space program, pride in being trailblazers, and interest in new research are declining?

Certain publishing houses, which react like a barometer to society's attitude toward space, are beginning to stop accepting manuscripts and are changing the dates for the publication of books on space themes. Ever more rarely, and in a time slot inconvenient for many, do we see on Central Television the special anthology "Man, Earth, Universe." No less vexing also is the fact that the country which opened up the space era has not even established a special magazine on the space program.

Some will consider this a detail by which it is impossible to judge large-scale processes. Well, this author does not claim that the conclusions are indisputable. It is another matter that what is becoming indisputable for most specialists that a certain scorn exists in society's attitude toward the space program and that the space program is being relegated to that group of scientific and technical sectors which, as it were, cannot even control the priorities in their own development. It seems that such shortsightedness should be exposed in a well-reasoned way to the Soviet people.

Profitability of Cosmonaut Missions to 'Mir'

LD0509181290 Moscow TASS in English 1743 GMT 5 Sep 90

[By TASS correspondent Rena Kuznetsova]

[Text] Moscow September 5 TASS—For the first time in the history of Soviet space exploration, a tangible profit could be obtained as a result of work by the sixth space expedition on board the Mir space station.

The profit, earned by Anatolly Solovev and Aleksandr Balandin, might reach 13 million roubles. Specialists believe that the current expedition by Gennadiy Manakov and Gennadiy Strekalov will be no less profitable.

The sixth expedition took over 2,000 photographs of the earth's surface and the ocean. Each of them cost some 1,000 U.S. dollars on the world market.

Nobody has yet transferred money to the account of the Glavkosmos for the "space products," and the sum of 13 million U.S. dollars is hypothetical, head of the Soviet Glavkosmos Aleksandr Dunayev said.

Eight dark crystals with perfectly smooth surfaces, grown in space, could adorn a ring of any fairy-tale king. A collection of semiconductor materials, obtained at the Gallar and Krater plants on board the Mir station, will be used in new technology. Specialsts believe some of them will revolutionise microelectronics. As for the crystals' price, each one costs some 500,000 roubles.

The new Kristall technological module, included in the Mir station, will help smelt a considerable amount of a composite semiconductor material, which is expected to repay the expense on the module and its launch.

Unfortunately, industrial production in space has yet to reach the level at which it can help repay expenses on manned flights. Foreign specialists believe that a kilogram of composite material, obtained in space, should cost from one to 3.5 million U.S. dollars on the world market.

State Commission Chairman Kiyenko on Economic Impact of Satellite Programs

907Q0080 Moscow SELSKAYA ZHIZN in Russian 12 Apr 90 p 3

[Interview with Yuriy Pavlovich Kiyenko, deputy chairman of the USSR Council of Ministers' Main Administration of Geodesy and Cartography and chairman of the State Commission for Launches and Use of Cosmos-series, Resurs-type Satellites, by SELSKAYA ZHIZN correspondent V. Shcherban, under the rubric "Today is the Space Program Day": "The Satellites Are Launched at Dawn..."; first two paragraphs are source introduction]

[Text] **For 16 years, there was an impenetrable shroud of secrecy surrounding him. All this time, his work was reported in the press dryly: "... the next satellite in the series was launched." And if they ever showed him on television, it was only from the back, and that just a glimpse. The chairman of the State Commission for Spacecraft Launches has always been a big secret. On the eve of the Space Program Day, we met with him. Just before the interview, he again called someone at the "top" and asked, "Then it's OK?.."—and, after hanging up the receiver, he said, "Well then, let's begin..."**

Our interviewee is Yuriy Pavlovich Kiyenko, deputy chairman of the USSR Council of Ministers' Main Administration for Geodesy and Cartography and chairman of the State Commission for Launches and Use of Cosmos-series and Resurs-type Satellites. He is over 50 years of age. A hale man of few words. During the year, he spends many a day roaming the cosmodromes. The satellites he has launched have never fallen back to earth or exploded, and they have sent billions of pieces of information from orbit. He has written more than 100 scientific articles and is an Honored Scientist and Engineer.

[Shcherban] Yuriy Pavlovich, every now and then there are reports in the newspapers about the satellite launches. And behind all of them stands a mysterious figure—you. What kind of work does the state commission chairman do?

[Kiyenko] It is somewhat odd that I am of interest to you. I am neither a cosmonaut nor a general designer. I am a civilian. The state commission chairman coordinates and supervises the operations associated with the testing and use of space equipment. An enormous

number of people participate in those operations. The information needed for making a decision about launching a space vehicle and for supporting the work during the flight converges at the chairman's desk. Accordingly, he alone bears all the responsibility for how a launch will go and for the safety of the people...

[Shcherban] It is only recently that we have begun to learn the truth about the launches of manned spacecraft. Along with the successes in that area, there have also been failures: people have died, and crews have returned from orbit with nothing... But there has never been any such information about the launches of the robot satellites. There has been total silence on that score.

[Kiyenko] It's no secret that work with space equipment is dangerous. Very complicated situations come up. But I have never been involved in a single instance in which someone has died or has received a serious injury. So if you are expecting "sizzling" facts, then, I'm afraid I'll disappoint you. Space robot systems—unlike a human, who has one head, one heart, and two hands—all have one, two or even three back-up systems. That is why the space robots are more reliable. Man is needed in space for testing new equipment and for conducting unique experiments. When all the bugs have been worked out, then the automated equipment successfully replaces man. Although, even I have had some emergency situations come up. I have had to postpone launches when I didn't received absolute assurance that systems would work efficiently or when flight programs needed to be adjusted. Once, we discovered one person missing among the evacuated participants in a launch. The launch had to be put on hold. We organized a search party for the missing person. He had been sleeping quite comfortably in a safe area the whole time.

[Shcherban] What's the result of delaying a launch for a minute?

[Kiyenko] In such an extremely complicated matter, the slightest interruption leads to an unbalancing of the system. Which means that there is a lesser degree of probability that we can produce the needed results. A whole set of research operations must be performed to determine the launch time. The entire collective really gets "thrown off" whenever there is any kind of delay during a launch.

[Shcherban] Every time spacecraft are launched, the specialists assert that it will facilitate the development of the national economy. What kind of return have your spacecraft given to the national economy?

[Kiyenko] It is difficult to state precise sums in rubles, since the application of space technology is multifaceted. Well, for example, to make a map or to study the ecological situation in a given region, an airplane can be used, or a satellite. The space-derived information will be 3-4 times cheaper than that derived by airplane. But how many millions is the recent discovery from orbit of the causes of the Aral Sea catastrophe worth? These days, the Ministry of Land Reclamation and Water Resources and the agricultural industry are rightly being named as the primary culprits in the drying up of the Aral. But it turns out that they are not the only ones at fault. In the middle reaches of the Amu-Darya and Syr-Darya rivers, the earth's crust is sinking. And at the mouths of those rivers, it is rising.

The difference in elevation between the mouth and the middle reaches changes by 10-15 millimeters a year. Nature is building a dam naturally at a rate of 1.5 meters a century! Underground aquifers have enormous reserves of fresh and slightly mineralized water. If the Aral Sea today has 450 cubic kilometers of water, the underground geological lenses beneath the middle reaches of the rivers have accumulated something on the order of 20,000 cubic kilometers. This will help solve the region's ecological problem! It will means billions of rubles saved!

And what about satellite prospecting for oil, gas and coal? Drilling just one dry well means millions of rubles down the drain. And what about controlling desertification? It was established from orbit that, in Kalmykia, 40,000-45,000 hectares of land per year are becoming unusable because the land is being covered with sand, and the reason for that—overgrazing by cattle. And what about the number of underground water deposits that have been found? Satellites have identified hundreds of thousands of hectares of eroded soil. If it weren't for them and the measures taken thanks to them, you and I would have no bread at all...

[Shcherban] I would love to share your optimism. But here among the people far from space a somewhat different opinion has formed regarding its development. It's no accident that demands have been voiced at the Congress of People's Deputies for a reduction in the allocations for space... There was no sausage or butter in the pre-space era, and there's still none. Even though more and more satellites are being launched. Might it not make sense to reconfigure them and to concentrate on solving the problems of today? I believe that people would vote for that with both hands.

[Kiyenko] Well, first of all, the launches of space vehicles are not increasing. Just the opposite. And that's not because we are becoming convinced of the flights' ineffectiveness. The reduction is happening because they are becoming more effective and are lasting longer...

Let's imagine for a just moment that we abandoned the use of satellites and that we plunked down those millions for the purchase of meat. We would reduce substantially the effectiveness of the operations for investigating the country's natural economic potential. At present, space-derived information forms the basis of operations involving the search for raw materials and the study and inventory of the country's forests. That information is important for the study of agricultural resources and seismic hazards, and for the analysis of the engineering and geological conditions in areas that have nuclear electric power plants... I could continue the list ad

infinitum. We would lose much, much more than we would gain if we abandoned the space programs.

It's another matter that the data from space-derived information is underused. And that use, basically, only for the development of industry. Agriculture is receiving only a miserly portion of the space pie. And yet, information that is of value to agriculture is being passed on regularly to the agricultural industry. For example, a comprehensive study of natural resources was recently conducted in the Central Asian republics. In arid places, we found lands with good forage resources, and we mapped them out.

[Shcherban] Mapped them out? No matter how many kolkhoz and sovkhoz representatives I questioned at the local level about how they are using the materials of space surveys, they just shrugged their shoulders: they hadn't heard a thing about it. Most of them don't even know what it is.

[Kiyenko] Well, I don't know whom you talked to there... Is it really necessary to get the space-survey results to the farm managers? It's the land-use surveyors in the oblasts and the republics who should be familiar with them. But you are right in saying that the farm managers are not very interested in the space information. Moreover, there is a certain pessimism in their attitude toward it. Why? The main reason lies in the ineffectiveness of the existing mechanism for introducing what is new. The system operates in such a fashion that people are not interested in what is new, because, after its introduction, they receive a smaller wage.

The space program must be viewed as a locomotive which is pulling behind itself a long train of basic and applied sciences. If all the achievements we have brought back from space were introduced today, then there is no doubt that an enormous economic impact would be felt in many sectors of the national economy.

[Shcherban] Each new launch of a spacecraft, it is asserted, produces wounds in the ozone layer which do not heal for a long time. And if you consider the fact that we are launching hundreds of space facilities, then that very layer reminds me personally of a sieve. Does the chairman of the state commission have his deputy for ecology close at hand? And, in general, is any one determining the effect of the space launches on the environment?

[Kiyenko] The rockets which we use to place the Cosmos and Resurs satellites into orbit are ecologically clean. And they do no harm to the ozone layer. They discharge a smaller amount of combustion products than do the automobiles of an average-sized city. And, in general, it one can't that a rocket punches a hole in the ozone layer. No one has ever even recorded such phenomena above the cosmodromes. And, with regards to the deputy... During launches of space vehicles for the study of natural resources, I have close at hand specialists from the Priroda State Center, who, believe me, know what's what in ecology matters.

[Shcherban] As chairman of the state commission, you know better than anyone else what the bill is for spacecraft launches. Couldn't you cite a couple of figures from this document?

[Kiyenko] Resurs-F, when it completed its program, produced an economic impact of 20 million [rubles]. That exceeded the cost of the vehicle, the rocket, and the launch many times over.

[Shcherban] Many of our readers are convinced that the entire space armada circling our globe serves, to a large extent, the interests of the military-industrial complex. In the final analysis, majors and colonels aren't launched into space so they can observe from orbit how the winter sown crops have sprouted, are they? For what purpose, it is being asked, have we achieved the world's highest resolution with our cameras—down to 5 meters—which can be used to view the wheat crops in detail from space...

[Kiyenko] The satellites which are being placed into orbit under the supervision of our state commission are intended solely for solving national economy problems. It is peaceful technology. And by the way, thatspace armada, as you call it, is more like a small flotilla in comparison with the one which is working for all the other sectors. We cannot even satisfy the demands of our consumers. Throughout the country, more than 1,100 organizations use space survey materials to solve approximately 300 national economy problems. At customers' requests, we are passing on as much as a million pieces of space information. We are supplying it to more than 60 countries around the world for hard currency. And it's only because of the shortage of space equipment that we can't saturate the domestic and foreign markets with its products.

If we want to have enough sausage and enough butter, then we should talk about increasing that armada. Indeed, the demand is there! Just one space photograph costs anywhere from $1,000 and $4,500. And as for the majors and colonels, I will say this: their training, skills, and reactions and the way they think are perfectly suited for ensuring that the expensive space missions are completed successfully.

[Shcherban] It sometimes happens that satellite fragments which have not completely burned up fall to Earth. They are quite often taken for UFOs. Such falls, so our readers assert, have recently become more frequent. Incidentally, one such burned fragment, a spherical object, recently fell on a cornfield in Voronezh Oblast. Fortunately, no one was hit. Can you guarantee that some unburned chunk of space metal won't ever crash through the roof of someone's house somewhere?

[Kiyenko] I'd call that a loaded question. Yes, I do know of instances when remnants of spacecraft have returned to the ground against our wishes. They are, beyond all doubt, anomalies. Such instances have been written up both in our country and abroad. But in any specific

instance, it must be determined what country the fragment belongs to. Our equipment has been designed so that nothing is supposed fall back to Earth and, if something does fall, that it does so in completely unpopulated areas.

[Shcherban] Incidentally, regarding unpopulated areas, from where are your satellites launched?

[Kiyenko] We prefer to operate from the Northern Cosmodrome in Arkhangelsk Oblast. During powered flight, the rocket flies over unpopulated areas: taiga, tundra, marshes, and the Arctic Ocean. Frequently, the launches take place at dawn.

If only you knew how beautiful the cosmodrome is at that time of day...

Specialists Justify Expenditures on Space Program

904A0535A Moscow EKONOMIKA I ZHIZN in Russian No 31, Jul 90 pp 12-13

[Report prepared by N. Tarasenko of meeting of the EKONOMIKA I ZHIZN "Business Club," chaired by Yu. Yakutin: "Space Economics: Feeling the Sharp Edge of Change"]

[Text] Recently, people have begun to speak out loud about space once again. To be sure, by contrast with previous years, these discussions, to put it figuratively, are more and more frequently on the down side. One of the most widespread opinions: You cannot find soap or sausage to save your life, yet here you intend to fly to Mars. Would it not be better to spend the people's money to buy goods and food. Through this rather dense chorus of voices in the parliament and periodical press a different judgment breaks through: If we mothball space research—we will be thrown back many years in scientific-technical development and will come to a stop in socioeconomic development. The opinions, as we see, are at opposite poles. On whose side is the truth?

V. Barsukov, member of the USSR Academy of Sciences and director of its Institute of Geochemistry and Analytical Chemistry imeni V.I. Vernadskiy:

Astronautics is losing confidence.... Is that right? I am convinced that it is not! It is simply a change of emphasis that is taking place in our life. It has made the transition from the sensation of the first launches to the category of purposive explorations, which are just as important, but have become an everyday occupation. That is what it is all about. When for well-known reasons it is difficult for a man to obtain food, in some places to buy the things he needs, this, of course, is of greater concern to him than research in the field of space.

In space research we still are not behind, and in some respects we are even leading the advanced countries. Now they are saying: expenditures for space have to be cut back. This is the wrong approach. We must bring along industry as a whole, all the branches, up to our achievements, not cut back the highest level to the lowest benchmark. That way we not only lose what we have, we condemn ourselves to a perpetual lag in the future. The discussion of why we should fly to Mars when there is no sausage—that is a purely Philistine position. There may not be any sausage even if we postpone the "Mars" Program and are not concerned about strengthening the agroindustrial complex.

Chairman:

We fly to the Moon, we look at Earth from space, but what is the benefit from that research, if not today, then at least in 10 years?

V. Barsukov:

On Earth, there are the so-called large annular structures. They can only be seen from space. We have now learned that ore deposits are concentrated in those annular structures. There is an economic benefit for you.

I will give another example. We discovered unoxidized iron in the lunar soil. We began to study the nature of the phenomenon and discovered: the lunar soil is subjected to intensive solar radiation. This discovery is now being used on Earth. To protect necessary and valuable parts against erosion, they are irradiated with protons or ions. In this way, a protective film is created in the form of unoxidized pure iron.

Yu. Kiyenko, distinguished figure in science and technology, deputy chairman of the Main Administration for Geodesy and Cartography of the USSR Council of Ministers:

Our department is concerned with the problems of using space information for remote probing of the Earth in order to study land resources and the environmental situation and for mapmaking.

Today more than 1,100 enterprises and organizations in various ministries and departments are using space information in our country. In those organizations, about 300 different national economic, scientific, and applied problems are being solved with material from the remote probing of Earth from space. Every year about 1 million units of space information are placed at the disposition of our country's consumers.

Soviet information surpasses foreign information on such indicators as geometrical precision and spectral characteristics. We are getting pictures whose resolution is twice as good as that of the French and 6-8 times as good as the American.

Not so long ago we went onto the external market with our product. What stood in the way of doing that earlier? First, the stamp "Secret." Second, the market had long ago been divided between the Americans and the French. Incidentally, other countries—China, India, Japan, and Brazil—are also working in the field of remote probes today. So to penetrate the market, we had

to make a statement about the high quality of our product. Today it is recognized, and now we are delivering our information to more than 60 foreign trading partners. Including firms from the United States, West Germany, France, Canada, Brazil, and Argentina.

Question from the floor:

Is our information being sold at world prices?

Yu. Kiyenko:

Our prices are commensurate with world prices and are determined by conditions on the world market.

The role of space research is sometimes inestimable in many fields of our life. Everyone is aware of the problem of the pollution of Neva Bay. So here is what space photographs made at various times indicate: The essence of the problem lies not so much in the dike built there as in the Neva's pollution by the city.

Certain hotheads are now proposing that we tear down the dike. But they take no notice at all that many enterprises and the city itself are discharging untreated effluents into Neva Bay. A comprehensive program to improve the treatment facilities of enterprises has thus remained words on paper.

There has been mention here of the effectiveness of space research. I will go back once again to the facts and figures. In 1986, 130 mineral occurrences were discovered from the data of photographs. In the petroleum and gas industry that same year, 436 sites were recommended for verification. The figure in 1987 was 586. Approximately 70-80 percent of them were confirmed. The prospecting of deposits with drilling would have cost 10 times as much.

We are "discovering" Antarctica. And we have to say that Soviet specialists were the first to do space photography of the icy continent. The study of Antarctica from space costs approximately one twenty-sixth as much as by the traditional method.

By means of space photography, we have checked the use of land resources in various regions of the country. It turns out that distortions in land records represent between 15 and 50 percent.

And finally. The military people are right now getting a great deal of harsh abuse. I am not a military specialist, but I must say that the subdivisions of the Ministry of Defense are a powerful constructive force in the national economy. Without the proving grounds of the Ministry of Defense, without using the intelligence of officers, the state would not have been able to exploit present-day space technology.

V. Balebanov, professor, deputy director of the Space Research Institute of the USSR Academy of Science:

We cannot do without basic research. There are no two ways about that. That is why the flight to Mars is inevitable. Whether we like it or not, man will begin to colonize Mars in the middle of the next century. If, in addition, we detect on that planet substances containing oxygen, then the atmosphere could be "corrected."

At present, we do not know what is in the asteroid belt of Mars. Perhaps we will discover something valuable in the asteroid belt. After all, only actual flights made it possible to understand the particular features of the planet Venus.

We have been studying the astrophysical phenomena of distant worlds. So far, science has denied the existence of other civilizations. But suddenly?!

What is our position in the world "rankings"? Soviet basic research is generally recognized. The scientists of many countries in the world are actively cooperating with us. Even in the most difficult times of the Cold War Barsukov, member of the academy, did not break off contacts with the Americans.

Now that the situation in the world has improved considerably, we have signed new agreements with NASA on a mutual exchange of instruments and experiments in space, on an exchange of scientists. The possibility has emerged of coordinating our efforts. For example, we are proposing a joint project to bring soil from Mars to Earth.

Only one conclusion can be drawn: If the state intends not only to preserve the heights which have been achieved, but to raise the level still higher, it must not refuse to finance basic research. In a civilized society, science is financed from the budget. This certainly does not mean that we are sponges on the state. Science, as history demonstrates, enhances the economic might of the state.

Chairman:

Is this situation possible. Under pressure of the public and the passions of mass meetings, basic science ceases to exist, and they tell you: "Concern yourself with applied science!"

V. Orayevskiy, doctor of physical and mathematical sciences, director of the Institute of Terrestrial Magnetism, the Ionosphere, and Radio Wave Propagation (IZMIRAN):

Then we will find ourselves in the Middle Ages.

In the words "scientific-technical progress," the word "science" comes first. First the idea, and then the embodiment. If we do not give birth to an idea, then there will be no embodiment at all. Our applied science feeds on the results of basic research.

B. Chertok, corresponding member of the USSR Academy of Sciences, deputy general designer of the NPO "Energiya":

Let me break into this conversation, since from the very beginning I have had occasion to be close to the sources of Soviet astronautics. And at that time there were no disputes about who should be given priority, basic science or applied. Everyone involved in it understood that there had to be a unified and inseparable system.

There are a multitude of examples in which basic research preceded the development of astronautics as such and its main capabilities. They made it possible to develop applied research. And there was no division between these two directions. To be sure, credit needs to be paid here to Keldysh and other major scientists of the USSR Academy of Sciences. At that time, the Academy of Sciences took a far more combative stance concerning astronautics.

Now we have occasion to hear rather often: Little use is being made of your advances for the benefit of the people. So, the remark is valid, but only in part. If the economic mechanism of our economy were structured somewhat differently, then many of our innovations would have been applied in all spheres of life. Take, for example, the system of telemetric monitoring. We determine how the astronauts feel hundreds of kilometers away. Yet that same technology could be used on Earth, say, in hospitals and at nuclear power plants.

We need to give some thought on how to organize an economic mechanism that would stimulate the use of the immense intellectual potential and advances of astronautics in all other sectors of the economy. There has already been mention here of the problems of studying land resources. How are the real capabilities of space technology being used to study the Earth "by other people" and by us? The American intelligence service does forecasts of wheat yields even in the Soviet Union. It is from those forecasts that prices are arrived at when grain is purchased. Yes, the Americans have made solid use of space in the economy. Our agricultural people have shown no similar interest as yet in space information.

Chairman:

Consequently, you feel that there never was a "stagnation" in our astronautics. Then what was it, in your view, that generated people's adverse attitude toward your sector?

B. Chertok:

One of the reasons lies in the absence of glasnost. Because of secrecy, little was written about the capabilities of astronautics and the new technological advances related to space technology. At the same time, only the showy facade of astronautics was presented, and that began to cause irritation. Whenever we failed, it was either covered up or it was presented in a form that had been touched up. And that always results in paradoxes. I have written a book about the achievements of rocket engineering and control technology. And in it I took the risk of telling how the Germans developed the V-2 and what its control system was like. The book went through all the official steps, and at the last hurdle they invited me in and told me that they had been forced to break up the type. Why? They answered: As you have told it, it turns out that the Germans had wonderful advances?!

In the time that was most difficult for American astronautics, after the death of the Challenger, they also began "backbiting." Then a commission was created which came to the conclusion: The achievements of astronautics over the previous two decades exceeded all the scientific-technical advances which humanity had had in its previous history. But we are continuing to debate: Do we need astronautics or not?

V. Ryumkin, candidate of engineering sciences, leading space specialist of the USSR Ministry of Defense:

In recent years, we have had to face a lack of understanding of the economic problems in the area of building and applying space systems, the specific nature of this unique technology, which cannot be approached with the standards of large-volume machinebuilding production.

What I mean is that astronautics is strong when the Soviet Union is strongly unified. Interregional collisions and conflicts adversely affect astronautics. In our country, after all, things which are one of a kind are made as a rule on the periphery. That accounts for the delays and breaches of contractual obligations. Should this process continue, we will be lagging further and further behind.

Since we have met in the editorial offices of EKONOMIKA I ZHIZN, I will answer the question about the yield of the ruble invested in space. We use a generally accepted method for comparing results, and the comparisons show: the effectiveness of space solutions compared to traditional methods of research provides a yield of up to 300 percent. What is more, many problems are simply not solved without space. Providing communications in remote areas of the country, for example, or the missile launch detection system.

Now strategic offensive weapons are being reduced and international thaw is taking place. But if it were not for national reconnaissance facilities, there would be no trust between the USSR and the United States.

At present, how are we to make the division between military space and civilian space? Figures have been referred to in the USSR Supreme Soviet. But they are highly hypothetical. No one will say where one space begins and the other ends.

However paradoxical it may sound, some of the expenditures incurred in launching spacecraft for scientific and economic purposes, which were financed from the defense budget, did not actually come under military expenditures. What is more, outlays to build general-purpose space systems (launching complexes, ground control systems, injection systems, etc.) used both in the

interests of defense and also in the interests of science and the economy were financed out of the defense budget. That is how it has gone historically. And that is justified because of the complexities of operating multipurpose systems. This applies all the more to dual-purpose space complexes, many of which were originally built for military purposes.

Chairman:

Viktor Mikhaylovich, as you know, 3.9 billion rubles were spent on military space in 1989. You said that all of this is hypothetical, and nevertheless no mention is made of redistribution of a portion of those funds for scientific or national economic space.

V. Ryumkin:

Out of the total expenditures for space technology, we spend 55 percent for military space, while the Americans spend 75-77 percent. That is why I put the question not so much about redistribution as about adding funds in both places. I will give just one figure: the information from space systems increases the effectiveness of the armed forces 1.5-2-fold. That means both a reduction of material costs and a saving on money resources.

V. Aksenov, USSR pilot-cosmonaut, general director of the NPO "Planeta":

I would like to briefly present the main directions of our scientific-production association. They are environmental monitoring and integrated evaluation of the environmental condition of areas, above all those in a critical state. Inspection of disaster areas to forecast their state. Establishment of land records, evaluation of the condition of soils, pastures, types and degree of pollution of inland waters. The study of geological structures and exploration for minerals. Study of the regions of the Far North and Antarctica. Compiling and updating topographic maps, including large-scale maps. The study of climatic processes, the oceans with respect to surface temperature, content of biologically active substances, pollution, currents, waves, and wind over the surface. This is only a portion of the tasks performed by the NPO.

Our products go to consumers in 22 departments, and the demand for them is also high abroad. When it comes to economic efficiency, our revenues cover our costs tenfold on the average.

Consumers have a very high opinion about the quality of our information. But there are also quite a few serious problems. One of them is that the satellites do not last long—less than half a year. Our wildest dream is two years. The American satellites "Landsat-4" and "Landsat-5," launched in 1982 and 1984, respectively, are still in operation.

One very serious problem is that we have nowhere to record and nowhere to store space information. For the last two years, we have had requests from Denmark and England that we sell them information on their areas. But we can only separate it by hand—unfortunately, there is no data bank.

Now as for cost-accounting relations and profitability in astronautics. In this area, we differ little from other sectors of the economy. The situation has to change greatly if our entire economic mechanism is to become far more receptive to scientific-technical progress. We have begun to develop commercial operations, we are gradually taking our data onto the world market. But even here there are plenty of problems.

We have no systems for the development, processing, and reproduction of information. We need channels for transmission of this information to consumers. At times, things are simply ridiculous. At one point, they carried the data...in a suitcase. They went through customs clearance, and all the data were erased.

One very important point is this: Why is it that consumers in our country are still not pursuing space information? Once we attempted to discover what kind of economic benefits our effort could bring to geologists, agricultural workers, foresters, and fishermen. The Ministry of Geology reported 50 million rubles per year. And the next year the representatives of that same ministry declared: You are not providing us any benefit, brothers. What a metamorphosis? It turns out that when the USSR Ministry of Finance and Council of Ministers learned about the benefit, they took those 50 million rubles from the ministry's budget for the next year.

V. Pashintsev, sector chief in the USSR Ministry of Communications:

If they are going to discuss the problems of space in the USSR Supreme Soviet, then I would call the attention of the people's deputies to the development of satellite communication. And here is why.

In 1965, we launched the first communications satellite "Molniya-1," in 1972 "Molniya-3," in 1976 "Ekran," in 1978 "Raduga," and in 1980 "Gorizont." In the initial stage, when "space" communications were being created, we were changing the modifications of the satellites and were launching them every 3-4 years. And now since 1980 not a single modification has been made of the satellite "Gorizont," and yet communications are one of the most important directions in astronautics.

At the present time, 97 percent of the population is watching the first television program by satellite, and 91 percent gets two programs. But the problem has not altogether been solved, because there is still three percent of the population, and that means 10 million people, whom television does not reach. Second, there is an acute problem today of relaying republic programs. It is not possible to solve this problem with the existing satellites.

Telephone communication. Here we have connected the center to the most important regions. To be sure, here

again the coverage is not complete. In other words, we have guaranteed the necessary level for solving problems of the national economy. But satellite communications have not reached oblast and regional centers. But then a program was approved. The issue of financing immediately arose. And that brought things to a standstill. In general, the right hand does not know what the left hand is doing. The problem has been under discussion for an entire year in the USSR Council of Ministers, USSR Gosplan [State Planning Committee], and USSR Minfin [Ministry of Finance], but still there is no decision as to who is to pay for building new communications satellites.

In Place of an Afterword

Yu. Koptev, USSR deputy minister of general machinebuilding:

Quite a bit has been said about the conditions in which our branch lives being like a hothouse. We can state it officially: the average level of profitability established in our branch for series production does not exceed 13 percent, and for experimental design projects it does not exceed 18 percent.

In preparing for this discussion, we tried to summarize data showing the state of our astronautics in a comparison with the Americans. The share of expenditures for space programs in 1989 was 1.5 percent of our budget, while the Americans spent 2.6 percent.

Last year, expenditures for space in the interests of science and the national economy amounted to 1.7 billion rubles in the USSR, while similar purposes in the United States received $3 billion; in the case of the military program: 3.9 billion rubles in the USSR and in the United States $22.8 billion; and the program for shuttle systems: 1.3 billion rubles in the USSR and $3.8 billion in the United States. Now look what is happening in 1990. The Americans are making the decision to push the program for development of orbital stations. They are allocating it $2.5 billion. That gives them a total of $5.5 billion for the first direction, while in our country this item will be reduced.

They say that the Americans do not know what to do with their money, and they say that we cannot keep up with them. This is incorrect. They also have a budget deficit. But see what is happening in other countries of the world. England has gone to a level of financing of more than 200 million, France 1.3 billion, West Germany about 500 million, Italy 700 million, and Japan 1.3 billion (all in dollars). Moreover, in all the countries they are showing a tendency to increase appropriations for space programs.

And see how the number of countries with access to space technology is growing: in 1960—2 countries, 1980—13 countries, and in 1990—17 countries. India, Brazil, Pakistan, and the Netherlands are dying to have space technologies.... According to forecasts for 1995, Iran, Indonesia, and Argentina will join that list. So, are these also states that do not know what to do with their money?! No, in many countries today they understand the benefit from investing the resources of the state in development of astronautics. This direction affords the possibility of creating powerful technologies, profitable telecommunications systems, and environmental protection.

Now we are being told ever more insistently: Give us a saving in the space program. Our total expenditure is 6.9 billion rubles. Is this too much or too little? It depends on the angle from which you look at this question. Is it too much or too little when today in the country we have a volume of unfinished construction amounting to more than 180 billion rubles? We have above-allowance inventories of 247 billion rubles, we have nonproduction losses of 24 billion rubles. Losses in the agroindustrial complex: 20 billion for grain, 5-6 billion rubles per year for meat. That is why we do not understand proposals about the possibility of solving the country's socioeconomic problems through "discrimination" against a promising branch of the economy—astronautics. If the losses enumerated above were reduced only by 10 percent, then the benefit achieved would exceed all our expenditures for space several times over. Combating losses and inefficiency is understandable, combating the advances of scientific-technical progress is absurd.

We feel that today we need to win people over, popularize our achievements more widely, and speak honestly about our shortcomings. In this connection, I would like to express gratitude to the weekly EKONOMIKA I ZHIZN for organizing our meeting. We hope to continue the discussion that has begun.

Dynamic Behavior of Expenditures for Space Programs, Millions of Dollars

Country	1985	1986	1987	1988	1989	1990
England	156	154	201.5			
France	828	1025	1190	1200	1210	1270
West Germany	406.1	423	513.3	350	475	495
Italy						700
Japan	459	620	774	1100	1150	1250

Being Published for the First Time

Countries possessing the potential for development and production of space technology systems and launching their own or acquired (leased) carriers. The launching date of the first satellite the country has developed itself is taken as the existence of that potential.

Up to 1960	USSR, United States
Up to 1965	USSR, United States, Great Britain, Canada, Italy
Up to 1970	USSR, United States, Great Britain, Canada, Italy, France, Australia, West Germany
Up to 1975	USSR, United States, Great Britain, Canada, Italy, France, Australia, West Germany, Japan, China, Netherlands, Spain
Up to 1980	USSR, United States, Great Britain, Canada, Italy, France, Australia, West Germany, Japan, China, Netherlands, Spain, India
Up to 1985	USSR, United States, Great Britain, Canada, Italy, France, Australia, West Germany, Japan, China, Netherlands, Spain, India
Up to 1990	USSR, United States, Great Britain, Canada, Italy, France, Australia, West Germany, Japan, China, Netherlands, Spain, India, Sweden, Israel, Brazil, Pakistan
Up to 1995 (forecast)	USSR, United States, Great Britain, Canada, Italy, France, Australia, West Germany, Japan, China, Netherlands, Spain, India, Sweden, Israel, Brazil, Pakistan, Argentina, Indonesia, Iran

International associations (consortiums) for building (using) space technology systems. On the basis of date of establishment.

Up to 1965	Intelsat, ELDO
Up to 1970	Intelsat, ERSO, Interkosmos
Up to 1975	ITSO, EKA, Interkosmos
Up to 1980	ITSO, EKA, Interkosmos, Inmarsat, Kospas-Sarsat, Eutelsat
Up to 1985	ITSO, EKA, Interkosmos, Inmarsat, Kospas-Sarsat, Eutelsat, Eumetsat
Up to 1990	ITSO, EKA, Interkosmos, Inmarsat, Kospas-Sarsat, Eutelsat, Eumetsat, ASTO
Up to 1995 (forecast)	ITSO, EKA, Interkosmos, Inmarsat Kospas-Sarsat, Eutelsat, Eumetsat, ASTO

Intelsat—International consortium for creation and operation of commercial satellite communications systems. In 1964, 12 founding countries. Since 1973, known as ITSO.

ITSO—created from Intelsat. Now has more than 100 participants.

ELDO—European Organization for Building Rocket Vehicles. From 1962 to 1964.

ERSO—European Space Research Organization. From 1964 to 1975.

EKA—European Space Agency. International consortium.

Inmarsat—International consortium for the organization of efforts to furnish satellite communications to vessels in the merchant fleet. Since 1979. Established by more than 20 countries, including USSR.

Kospas-Sarsat—International consortium for organizing notification of aircraft and vessels which have had accidents and search for them by means of satellites.

Eutelsat—Organization for operation of West European communications satellites. Since 1979.

Eumetsat—International consortium for development and operation of weather satellites. Created by 17 countries in 1983.

ASTO—Organization for creation of a satellite communications system based on the satellite ARABSAT. Established by 22 Arab countries.

Other countries which are active participants in space programs: Switzerland, Denmark, Austria, Finland, Luxembourg, Czechoslovakia, Bulgaria, Poland, Hungary, and the GDR.

	Specific Annual Economic Benefit (Billions of Rubles)	
Purposes for Which Advances of Rocket and Space Technology in USSR Are Being Used	1988	1990 (Anticipated)
Meteorology, environment	0.75	0.85
Exploration for natural resources		
Land	0.35	0.85
Communications, television	0.60	0.75
Navigation	—	0.10
Materials science	0.30	0.40
Technology	0.15	0.20
Other	1.00	1.00
Total	3.15	4.15

Comparison of Expenditures for Space Technology With Certain Economic Indicators of the Country's National Economy (Billions of Rubles, 1989)

USSR space budget	6.9
Volume of unfinished construction	180.9 (26-fold)
Grain losses	20 (threefold)
Above-allowance remainders of merchandise and supplies (as of 1 October 1989	247 (35-fold)
Nonproduction losses	24 (3.5-fold)
Acceleration of rate of turnover of working capital by 1 day	8 (1.2-fold)
Meat losses	5-6
Stocks of uninstalled imported equipment as of 1 October 1989	5.8

Status of 'Mars-94' Mission

907Q0110A Moscow IZVESTIYA in Russian 3 Jun 90 Morning Edition p 6

[Article by S. Leskov: "The Next Goal Is Mars"]

[Text] **One more large space-related installation has been declassified—the NPO imeni Lavochkin, where, among other things, interplanetary space stations are made. A group of foreign journalists, who visited the famous design bureau for the first time, was interested most of all in the program for research on Mars.**

In the next few 5-year plans, the center of gravity for interplanetary research in the Soviet space program will shift from Venus to Mars. The study of Mars is a large state program, which begins with modest tasks for the purpose of selecting future landing regions for mobile self-propelled devices and the delivery of Martian soil to Earth. After a comprehensive scientific examination, first of all biological, a decision will be made about a manned flight to Mars.

The next item in this program is the Mars-94 project. The mission's launch has been planned for August of 1994. Contemplated is the investigation of the Martian atmosphere using balloon cylinders reminiscent of the one which floated in the Venusian atmosphere in the course of the Vega project. It is being proposed that the surface of Mars be investigated using small meteorological stations and a special descent probe which should, after hitting the ground at a speed of 100 meters per second, bore deeply into the planet's surface. At the same time, a 500-fold g-force increase is expected and it is necessary to solve the problem of the safety of the equipment, including the sensitive television camera, the manufacture of which is being undertaken by Japanese specialists.

As is well known, the study of Mars is also part of the USA's space plans. Recently, a certain rapprochement to the possibility of joint research has been observed. But, in the opinion of R. Kremnev, the chief designer of the Scientific Testing Center imeni Babakin, NASA, for the time being, is disturbed by the political prospects of cooperation and, therefore, it does not dare get involved in long and large-scale joint projects.

The cost of the Mars-94 project, so it is assumed, will turn out to be approximately the same as for the Fobos project—around 300 million rubles. At the same time, R. Kremnev complained that the accident with the Fobos craft is partially explained by the fact that the designers were not warned by the project's scientific advisors about the existence of meteorite belts on the craft's flight path. Although, of course, the main problem remains the low level of quality of domestic electronics.

I remember that, during the preparations for the Fobos project, the scientists emphasized the enormous importance for science of the study of small heavenly bodies. Does the orientation toward Mars mean giving up the attempts to investigate this class of celestial objects? R. Kremnev noted that the unrealized delivery of soil from the Martian satellite, Phobos, is being retained in the long-term plan for further research on Mars. In addition, only the shortfall in the resources currently allocatable to the space sector makes it necessary to hold off a while on the project for landing a probe on one of the asteroids. Incidentally, even the Mars-94 project has been financed for the time being only for the current year. In connection with these difficulties, the leaders of the NPO imeni Lavochkin have expressed a lack of understanding of the position of the USSR Academy of Sciences, which is raising objections in some situations to joint financing with other countries of international projects. It is necessary in this connection to emphasize that, because of the mutual positions of the planets, any postponement in the mission's readiness or delay in the optimum launch date will entail a significant increase in the weight of the rocket and the fuel and, correspondingly, a reduction in the amount of scientific equipment.

Spending on Mars Program Criticized

PM1807145290 Moscow MOSCOW NEWS in English No. 28, 22-29 Jul 90 p 4

[Article by Leonard Nikishin "Fact And Commentary": "Who'll Fly to Mars?"]

[Text] USSR: as declared by A. Gorin, department chief at the State Committee for Science and Technology, 33 million roubles have been allocated in 1990 for the scientific-technical programme Mars, including the work to prepare a piloted expedition to that planet. Another

programme—Resource Saving and Ecological Clean Processes of Metallurgy and Chemistry—was given 25 million roubles.

USA: as TASS reports, in spite of insistent calls for support by President Bush, the US House of Representatives opposes giving money for any more long-term space programmes including the building of a station on the Moon or a manned flight to Mars.

Nevertheless, we tend to be irreconcilable romantics at heart. It's no wonder the bright future was what was most important for us for so many years. The economy is cracking, the shop counters are bare, our agriculture is backward, our society is suffering from ethnic tensions—and still, we haven't given up on the flight to Mars. And even though its performance will cost a sum that is out of this world [according to US estimates—some 100 billion dollars], we have already started to spend the first millions. In a country where some half the population lives below the poverty level. It's one more abused file in our existence, a heritage of "great feats in space," which was so loved by Brezhnev propagandists.

But maybe we expect to find something of value on Mars, or expect to colonize it? Well, of course, not because the "red planet" is a deserted, lifeless world, where a person without a space-suit cannot live for even several seconds.

US Congressmen have, apparently, calculated well, and think it is a waste of money to spend even a dollar on it—this, in conditions of wealth, well-being and stability. But we continue to fly by inertia.

Maybe the USSR Supreme Soviet will nevertheless decide it's possible to leave the honour of exploring Mars to our descendants and that the 33 million roubles would be better spent if used for the needs of Chernobyl victims or to buy medicine?

Controversy on Manned Versus Automated Space Missions

LD0608223290 Moscow in English to Great Britain and Ireland 1900 GMT 6 Aug 90

[Excerpts] A new two-man crew on Friday boarded the Mir space station, joining the crew who have been working there for half a year. But although the latest launch [words indistinct] went off practically without a hitch, they appear to have added fuel to the controversy in the Soviet Union over the future of the manned space program, and this is now explained in "Vantage Point" by Boris Belitskiy

[Belitskiy] [passage omitted] The second part of the crew rotation operation is scheduled for this coming Thursday when the crew they are replacing is due to return to earth. Their return will be watched with some anxiety. [passage omitted]

But despite unquestionable achievements of the Soviet manned space flight program, the latest operations have tended to reactivate criticism of it, particularly from the standpoint of its cost effectiveness—certainly a factor of great importance in these times of acute economic difficulties. Thanks to the policy of glasnost or openness, it's now known that the manned space program will this year cost 220 million rubles. It's also known that the Buran space shuttle, whose testing has still not been completed, cost R14 billion. Figures such as these are leading many critics to question the need for a manned space program for the present. The critics point to the much smaller cost of unmanned satellites. A communications satellite, for example, costs only about R10 million, and the investment quickly pays off.

As a result of such criticism, various alternatives are now being suggested to the present manned space program. For example, instead of the expensive Mir-2 orbital station planned for the mid-90s, a group of space designers have come up with a different project. This is a 100-ton orbital factory which would produce a ton of extremely valuable products a year. The factory would cooperate in the automatic mode and would require only two visits a year by cosmonauts for recharging its furnaces, removing finished products and routine maintenance. The cost of the project is estimated at R1.2 billion; the cost of the annual product at R3-8 billion.

On the other hand there are those who argue that manned space exploration is one of the few areas of science and technology in which the Soviet Union unquestionable leads the world. This leading role, they claim, will soon begin to pay off in financial terms too. [passage omitted] It remains to be seen which way the present debate tips the scales of the future of the Soviet manned space program.

'Yuzhkosmos' Center Formed for Space Commercialization

907Q0109A Moscow RABOCHAYA TRIBUNA in Russian 2 Jun 90 p 4

[Interview with Vyacheslav Stepanovich Fomenko, doctor of technical sciences, general director of Yuzhkosmos and recipient of the USSR State Prize, by A. Makukha, Dnepropetrovsk: "Space on a Cost-Accounting Basis"; date and place of interview not given]

[Text] **"Yuzhkosmos," a space rocket scientific testing center of USSR Glavkosmos and NPO Yuzhnoye, has been established in Dnepropetrovsk. V. Fomenko, general director, doctor of technical sciences and recipient of the USSR State Prize, talks about its tasks.**

"Our goal is the transition to commercial use of the space industry," says Vyacheslav Stepanovich. "It is necessary to bring the developers of rocket technology and their possible customers together. Yuzhkosmos was established as just such a 'little bridge'."

[Makukha] What are the first steps of such an unusual enterprise?

[Fomenko] A preliminary agreement has already been reached regarding the construction of a spaceport in Australia for commercial launches of satellites using our Zenit launch vehicles. This rocket is a modern, highly reliable launch vehicle, the only one of its class in the world, which operates on ecologically clean types of fuel.

In addition, we will be engaged in the introduction and dissemination of wind-powered electric plants. They are being developed in NPO Yuzhnoye. and, of course, we will be realizing those enormous capabilities installed in our satellites.

[Makukha] Do you believe it is profitable to sell rockets and satellites or the information obtained using them?

[Fomenko] Of course. According to USSR Goskomgidromet's [State Committee for Hydrometeorology] data, just the extension of the time frames for navigation in the polar regions with more qualitative space-based ice reconnaissance may produce an impact of 40 million rubles.

In talking about the economic advantage, money is not the only thing which must be kept in mind. It is sometimes difficult to calculate the threatened but narrowly averted harm. For example, in 1985, in the vicinity of the Antarctic continent, a ship, the Mikhail Somov, was surrounded by impassable ice. The operation to save it turned out successful thanks to the information about the ice situation, which was obtained from the Cosmos-1500 satellite.

[Makukha] Who, besides meteorologists, may become your permanent partners?

[Fomenko] With the launching of the Cosmos-1500 satellite and the development of the next generation of Okean natural resource satellites, an opportunity appeared for all-weather monitoring of the water surface and the earth. From the Okean, at any time of day or night and with any cloud cover, it is possible to obtain deciphered radar "pictures." Visible in them are the ice situation, the degree of pollution of the water's surface, the degree of roughness and the direction of the surface wind.

Now information from orbit is being "dropped" onto three receiving and processing centers. The main one is in the suburbs of Moscow, while there are two regional ones, in the Far East and in Novosibirsk. From there, it is passed on to the consumers.

Using satellite systems, it is possible to predict the harvest yield, take stock of land resources, monitor the state of the crops and the course of agricultural operations, conduct an early diagnosis of the spread of plant diseases and the path of migration of pests, and obtain high-quality cartographic material and information about the geologic and soil compositions of the land surface. It is possible to monitor on a real-time basis the development of forest fires and the state of the forest stands, the pollution of the water surface and the atmosphere and many other things.

Unfortunately, the circle of users of our information is still small: the hydrometeorology service, sailors and fishermen. This, perhaps, is all. The space systems are being used for the time being only for tests and experiments, yet they have enormous potential.

Throughout the entire world, enormous resources are being expended on the development of methods for remote sensing of the earth. For example, 4 billion francs have been allocated for the development of the French system. The American program for the coming decade is estimated to be 276 million dollars! And we should not lag behind the world-class level, for this is one of the few sectors where we are maintaining competitiveness.

We also have our own program—Aerokosmos. This is new information technology which will give a specific customer the opportunity to obtain the most diverse thematic pictures of interest to him. For example, maps of soil moisture, of the level of ground waters, of mineralization and pollution of the water and of the radiation situation.

[Makukha] Is it likely that such a version of conversion will require large capital investments?

[Fomenko] Undoubtedly, indeed, needed are computer modeling stands, aircraft, equipment for the launch sites for testing instrumentation and the instrumentation itself.

Our possible users-customers belong to the most diverse departments. Each of them separately will hardly be able to finance these operations. Abroad, all similar programs are financed as follows: the development of a satellite system and instrumentation is at the expense of the state, while the collection, processing and dissemination of the information is on a commercial basis.

We are putting forward a proposal to all interested parties that they organize themselves into an association [assotsiatsiya] of customers and developers. We invite the cooperation of ecologists, the environmental protection agencies and all interested parties. Our address is: 320059, Dnepropetrovsk, Ulitsa Krivorozhskaya 3, NPO Yuzhnoye. Telex 131223 Orekh, the Yuzhkosmos Rocket-Space Center.

Work Under Way At Southern Machine Building Plant

Ashkhabad TURKMENSKAYA ISKRA in Russian 24 Jul 90 p 3

[Unattributed article: "'Yuzhmash' Without the Seal of Secrecy"]

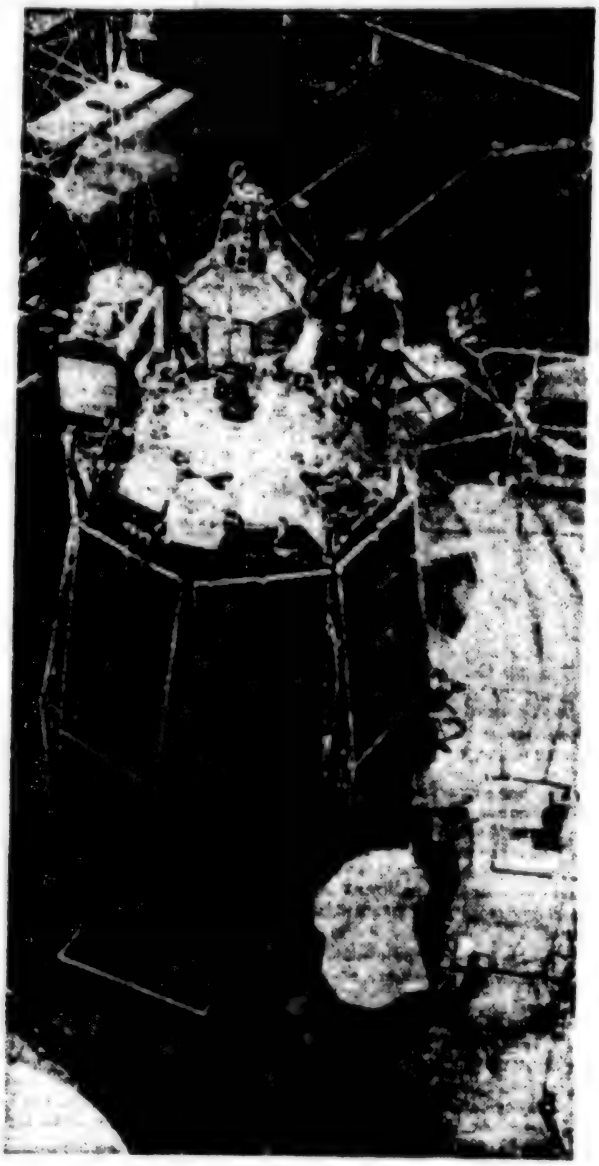
Ukrainian SSR. They still haven't gotten used to reporters at the production association "Southern Machine Building Plant." Indeed, before now people in one shop of the enterprise didn't even surmise about

what their colleagues in the next shop were doing. As far as the space rockets and satellites which were developed and assembled in the shops of the plant, it was considered a crime even to speak out loud about them. Even now the veiled term "article" will slip into a conversation instead of the understandable and concrete names "Zenit," "Okean," and "Cosmos."

One of the newest shops of the enterprise was specially built for assembly of the "Zenit" booster. Today this is the pride of the enterprise and of the design collective of the NPO. The date of its production start is considered to be 1988. A year ago foreign specialists were able to evaluate the "Zenit" at a European conference on aerospace technology which was held in Bonn.

In addition, the "Zenit" is practically clean in terms of the ecology. It operates on kerosene.

Foreign firms have shown an interest in the booster. The government of Australia has decided to build a cosmodrome in the north of the country for commercial launches of earth satellites using the "Zenit."



In the spacecraft assembly and testing shop final work is performed on automatic universal orbital stations (AUOS).

NPO 'Yuzhnoye' Director V. F. Utkin Interviewed

PM2408155090 Moscow KRASNAYA ZVEZDA in Russian 23 Aug 90 First Edition p 2

[Interview with Twice Hero of Socialist Labor Academician V.F. Utkin, general designer and general director of "Yuzhnoye" Science and Production Association, by Col. M. Rebrov; place and date not given; published under the rubric "The Time Has Come to Tell": "The 'SS-24' and Others.... A Frank Conversation With the General Designer of Strategic Missile Complexes on a Formerly Classified Topic"—first three paragraphs are an editorial introduction]

[Text] The number of "classified" topics, closed doors, and secret installations in our life is declining with each passing year. We are learning more and more truths—open, unembellished, and at times harsh—about the "post office boxes," "science and production associations," and "test sites" which are components of the defense industry. Or, more precisely, of the Soviet military-industrial complex.

The names of talented engineers are also becoming public, with hints of their direct involvement in missile and space work. It is only fair that we should come to know in their lifetime and not afterwards the daring and the inquisitive, those distinguished by lofty professional courage, the committed and the passionate, those "protected from strangers' eyes and recognized on a strictly need-to-know basis."

Our correspondent's conversation today is with Twice Hero of Socialist Labor Academician Vladimir Fedorovich Utkin, winner of Lenin and USSR State Prizes and general designer and general director of "Yuzhnoye" Science and Production Association.

[Rebrov] Vladimir Fedorovich, it would be naive and even absurd to imagine that a general designer of combat missiles and space rockets has no secrets. But they are more in the sphere of military, scientific, technical, and to a certain extent political problems. Let us talk first about the human and moral factor....

[Utkin] I agree. But why did you pick me of all people as your interlocutor?

[Rebrov] KRASNAYA ZVEZDA readers, and not just they, are especially interested in the position and opinions of someone whose name is associated with the main achievements of the country's strategic nuclear forces. Moreover, they are also intrigued by the curtain of secrecy which has hung for years on end over the activity of the collective you head. But my first question is on a different topic. Much is being said today about war and peace, the "nuclear deterrence strategy," the destructive force of modern weapons, and "anachronistic strategic thinking...." But there are also ideas like duty and a scientist's moral choice, good and evil.... Where does the truth lie?

[Utkin] The quest for truth must also be conducted for the sake of man's well-being. It must be meaningful. And if these conditions are observed, the quest will never lead a scientist to a confrontation between morality and truth, to a loss of his personality's moral foundations. Truth as such cannot be either "moral" or "immoral." As a colleague of mine loves to say, a surgeon's scalpel cannot be good or evil. Only the man holding it can be good or evil. Truth in a scientist's hands must be a scalpel of good. Such is the philosopher's stone of life.... When you develop output on which the country's security depends, you feel first and foremost tremendously responsible to your compatriots.

[Rebrov] The "nuclear deterrence" policy, as it is known in the West, demands the quest for an opponent. I can imagine the military's opinions and position. How about the designer's thoughts and views...?

[Utkin] A tough question. It was not we who started the "cold war." I have no intention of listing the military bases which were targeted on us and whose number was steadily growing, as was incidentally the quantity of weapons deployed there. That was a serious threat. And we designers sought ways to create an equilibrium. Our designs had to be equally as good.... I recall the summer of 1966, the year when launches of combat ICBM's from silos were demonstrated before the French president for the first time in the history of Soviet-French relations. That was at Baykonur. Endless steppe burned by the sun. Silent and stifling. Time was dragging. Tension increased once the five-minute stand-by was announced. It was intensified by the countdown of the last few seconds over the loudspeakers. Finally "Launch!" The earth opened up at that moment, balls of fire, smoke, and dust shot up, and the missile's body emerged from that seething inferno. The roar gradually intensified, painfully hitting the eardrums. The mighty and terrifying vehicle was on its way to the accompaniment of the rocket boosters' triumphant roar....

General de Gaulle stood still on the observation platform, eyes riveted on the emotive spectacle, exclaiming: "Colossale! Colossale...!" Our interpreter, a major, stood next to him and mechanically repeated: "Colossal! Colossal...!" I thought to myself then: This is true, but it would be better if it never came to real combat launches...

[Rebrov] Could you please put in plain language the secret concealed by the words "Yuzhnoye" Science and Production Association?

[Utkin] Our firm comprises the "Yuzhnoye" Design Bureau, the "Yuzhnyy Mashinostroitelnyy Zavod" Production Association, the Machine Building Technology Scientific Research Institute....

[Rebrov] And your output?

[Utkin] It is associated with the Strategic Rocket Forces. We have developed and manufactured the majority of

missiles on which the Soviet missile-space [raketno-kosmicheskiy] defensive shield is based. Our missiles have their own production code designators but appear in the U.S. classification list under the codes "SS-4" and "SS-9," being the old types of missiles, as well as "SS-18" and "SS-24" which are the latest....

[Rebrov] Within the narrow circle of specialists, your firm was initially known as "Yangel's" and now as "Utkin's." It does have a rich history.

[Utkin] Yes, and we are proud of this history. The design bureau and production base were set up at the height of the "cold war" when the United States and the NATO countries were trying to build their policy toward us from positions of strength. The plant was initially designed for motor vehicles, but.... At that complex time, back in 1954, the design bureau was headed by Mikhail Kuzmich Yangel. He has become a legend. His name and life have gone down for ever in the annals of the history of missile-space technology. Yangel was chief designer at the age of 43. Twice Hero of Socialist Labor and an academician, he died when his powers were at their height, full of ideas and plans, in 1971....

The collective's strength has always lain in its members. V.C. Budnik, L.V. Smirnov, A.M. Makarov, L.L. Yagdzhiyev, V.M. Kulchev.... It is hard to mention all the names. We worked in close contact with many of the sector's production associations, the USSR Academy of Sciences, military specialists.... We engendered a new form of collaboration between science and production. Here is just one example. The aviation industry had established the design bureau-experimental plant-series production structure. We reduced this chain: design bureau-experimental series plant. This is cheaper and more flexible, and it also has other advantages.

Despite the fact that the prestige of defense industry workers is now declining, it must be said that this equipment is made by the hands of a thousands-strong collective of workers, technicians, designers, and scientists with top qualifications.

[Rebrov] You became head of the collective in 1971 and, it must be said, the firm's glory is as great as ever. Vladimir Fedorovich, could we have a few more details about the specialized work done by "Yuzhnoye" Science and Production Association?

[Utkin] Over the last 35 years and more, we developed four generations of strategic missile complexes ensuring parity between the fatherland's nuclear missile forces and the corresponding U.S. forces.... In the space equipment sphere, we developed more than 50 types of satellites for military and scientific purposes. A total of more than 300 spacecraft have been placed in orbit at different altitudes. Add to this also several types of delivery vehicles.

[Rebrov] Which development in the last few years would you describe as the most interesting?

[Utkin] We have a demanding and strict client, meaning the military department, but the specific work of large design collectives is like all the work done by development and design workers—there are no uninteresting topics. I must admit, it is very hard to do an uninteresting job well. It is just uninteresting. This says it all. I would use a different term—significant, important.

I would describe as such the development and bringing into service of a new class of fourth-generation missiles in response to the development of the so-called MX missile by the Americans. Our highly efficient solid-fuel missile is designated by the code "SS-24" in foreign classification lists. It is not only silo-launched, but a mobile variety has been developed with missiles and the entire launch installation deployed on trains. Whenever necessary these trains can vary their location, which makes them less vulnerable to retaliatory strikes. I emphasize this.

It is also worth noting the high specification of the heavy missile known abroad as the "SS-18." There is nothing like it in the United States. At this point, however, I would like to make one stipulation: Our work has always been and is being done under strict observance of the SALT II Treaty.

[Rebrov] Vladimir Fedorovich, I read in the U.S. journal MILITARY TECHNOLOGY the following appraisal of the "SS-18," which by the way has been dubbed "Satan" in the West. This missile "is one of the largest and most highly efficient strategic systems representing a most brilliant achievement by Soviet military technology."

[Utkin] I also read this. Furthermore, the Americans believe that we will be able to maintain our nuclear missile potential at the proper level even if the treaty on a 50-percent reduction of strategic offensive weapons is signed.

[Rebrov] Let us leave politics aside for a while, we will come back to it later. What is the general designer's strategy?

[Utkin] Strategy...? It is the way to arrive at alternative scientific and technical solutions involving minimal expenditure in response to the deployment of corresponding categories of arms by the potential opponent. Such an approach makes it possible to cut down the time consumed and avoid what is known as trial and error. It was this path that produced what I consider the original and nontraditional solutions which determine our missiles' specifications today. Let me be more specific: I mean the creation [sozdaniye] of orbital multiple reentry vehicles, the development [razrabotka] of a unique mortar-type launcher for missiles from silos, the solution of the package of scientific and technical problems ensuring uninterrupted combat alert standby status for fully-fueled liquid-fuel missiles over a period of several years, and the package of constructive solutions ensuring missile resistance to a nuclear explosion's strike factors.

At this point I would nonetheless like to revert to political assessments. Strange though it may seem, by enhancing the efficiency of strategic forces we laid the foundations for slowing down the pace of the arms race and for building down entire categories of weapons. Thus, the creation [sozdaniye] of multiple reentry vehicles and of systems to overcome the opponent's ABM defense provided the technical basis for the U.S. side's build-down of programs to develop the "Safeguard" ground-based ABM echelon and the conclusion of the 1972 ABM Treaty whose importance is hard to overestimate.

[Rebrov] Unfortunately, it failed to solve all the problems. Moreover, in today's conditions, the U.S. side is pushing us toward shifting the arms race into space. This would require colossal economic expenditures.

[Utkin] I agree. I recently read Matthew Evangelista's book "Innovation and the Arms Race. How the United States and the Soviet Union Develop New Military Technology." The author has an interesting idea: "The United States has constantly fallen victim to the so-called 'last step' self-deception." In other words, at each stage of the race the United States calculated that this time the Soviet Union would probably fail to match it. The U.S. leadership must realize, Evangelista writes, that the U.S. technological advantages are not everlasting and will not offer security guarantees. This is what they themselves say.

I would also like to emphasize the following idea. Let us recall the not-so-distant past, when the "cold war" threatened to become "hot." One could cite a multitude of facts confirming the heating of international tension. I repeat, it was part of our duty to find an active countermeasure at each round of the arms race. The accumulated experience gives reasons to hope that we will succeed in countering the SDI program with a package of measures sharply reducing its effectiveness. This is the law of action and reaction, and I assume that this is realized by people abroad who are calling on the United States to refrain from extending the arms race to space so as to prevent any disruption of the recently emerged dynamics of transition to a nuclear-free world.

[Rebrov] Vladimir Fedorovich, since your "output" ensured and still ensures parity, it is natural to ask about the role played by missiles during the 1962 Caribbean crisis.

[Utkin] They were in Cuba at the time. We—the makers of strategic missile complexes—learned a special lesson from the crisis. A lesson in civic responsibility, of awareness of all the complexities of the moral aspect of the process of creating arms. Each one of us designers sensed more acutely at the time the fact that he bears responsibility not only for his own people's future but also for the world community's future. Actually, this was realized not just by designers, and not just by our side either. This is what I assume.

[Rebrov] Many readers are perturbed by this question: What is the price we have to pay for the constant confrontation and the efforts to ensure parity?

[Utkin] The implementation of military programs has swallowed tens of billions of rubles and has diverted funds from the needs of health care, science, culture.... The best specialists, scientists, designers, and workers with top qualifications were sidetracked into defense development and research. The burden of the arms race did have a certain effect on our country's economy as a whole. But no matter how paradoxical this might sound, we defense industry workers are aware better than anyone else of the importance of every single ruble diverted from the needs of social development.

Do not be in a hurry to interrupt me; I will explain at once. Our collective, at the very start of its existence, adopted an approach toward work which ensures the parallel utilization of scientific and technical developments in the interests of science and the national economy. Today we have achieved a technical standard whereby the majority of materials technology problems, and the technological and other scientific and technical problems associated with the creation of combat missile complexes, can be directly applied in industry as a whole. The problem is not to freeze but to utilize our scientific and engineering advances rationally and swiftly, without any bureaucratic red tape. I would make so bold as to describe them as not just innovative but actually revolutionary. Therefore, today it is legitimate and necessary to speak about the possibility of developing and creating prototype weapons with parallel and simultaneous satisfaction of the national economy's targeted tasks—new materials and technologies, new design solutions, new methodologies, and so on—and absorption of a sizeable proportion of costs through the national economy. Such experience already exists.

[Rebrov] Could you be more specific, could you give examples?

[Utkin] Let me begin with the fact that the "Kosmos" delivery system was created way back in the sixties on the basis of the "SS-4" continental ballistic missile. Later on our science and production association used the "SS-9" combat vehicle as a basis for developing the "Tsiklon" delivery vehicle. Some 12 years ago we proposed developing a delivery vehicle based on ecologically clean types of fuel. The "Zenit" delivery vehicle is in use at present. It uses liquid oxygen and kerosene. Its main specific feature is the fully automated launch. There are no people at the launch pad. The rocket is capable of placing in orbit 12 tonnes of payload, including manned craft. The first stage of this rocket is used as booster units—strap-on boosters for "Energiya."

What else? In parallel with the combat missiles' utilization for peaceful purposes, we developed an entire family of "Cosmos" satellites which make up approximately one-fourth of the total number of spacecraft in this series. The launch of the "Intercosmos-1" craft was a

memorable event in the peaceful exploration of space. That was in October 1964. The first "Intercosmos" marked the beginning of an era of joint exploration of near-earth space by our own and other interested states' academies of sciences. There were 24 craft of this series launched in the past, and 21 of them were developed at "Yuzhnoye" Science and Production Association. We developed "Aureole-1," "Aureole-2," and "Arcad" jointly with French specialists. The "Aryabhata," "Bhaskara-1," and "Bhaskara-2" satellites were placed in orbit in collaboration with India....

An example of solving major national economic problems is offered by, say, "Cosmos-1500." This satellite played a part in the saga of extricating convoys of ships which were ice-bound in the East Siberian Sea. Thanks to radar surveys which were carried out during the polar night in condition of heavy cloud cover, we were able to map out the best route to be followed by the convoys out of the ice. Hundreds of millions of rubles were saved. "Cosmos-1500" was the precursor of the now famous "Okean" satellite series which help seamen resolve navigational tasks.

The "Yuzhnoye" Science and Production Association is currently working on the creation of a new spacecraft which is intended to be used in three international projects for a comprehensive study of the Sun and the Sun-earth links. Several European countries and India will participate in the implementation of these projects. U.S. and Japanese specialists intend to conduct concurrent observations. Maybe other countries as well....

[Rebrov] As far as I know, the "Yuzhnoye" Science and Production Association is involved not just in missile-space projects.

[Utkin] This is correct.... For many years now our collective has been developing and producing the "YuMZ" wheeled tractor-cultivators. The 2 millionth tractor will roll off the lines in the very near future. Our vehicles account for one-third of the annual all-Union production of wheeled tractor-cultivators. The science and production association's designers have developed a total of 10 modifications for "YuMZ" tractors.

Pursuing the idea of the defense industry's conversion, let me say this: The science and production association is developing high-capacity wind-driven power generation installations. The first prototype was installed and started undergoing trials a month ago. A package of hardware is being developed for the oil and fats industry. An emulsifier—a device to extract solid dust particles from smoke gases released by heat and electric power stations—was created to solve ecological problems. This output is in demand in the country.

We have offered to enterprises in our own region and elsewhere our services for testing their output. The unique opportunities offered by our experimental base and our staffers' qualifications could enable the science and production association to become nationally and internationally recognized as a certification trial center for many categories of the most diverse output. If only we had items to certify!

[Rebrov] And so, the Dnepropetrovsk creators of missile-space systems perceive conversion not formally but substantively. How do you appraise the present state of affairs as regards the spread of conversion?

[Utkin] Unsatisfactory. Our position is based on many years of experience in conversion matters. In my view, and in order to remedy the currently prevailing situation, it is first of all necessary to retain the specialized collectives which created the strategic complexes that enabled us to achieve parity with the United States. Second, it is necessaryt to ensure maximum access to world markets for defense industry enterprise with science-intensive—I emphasize this—output based on the strategic complexes they have developed, the use of delivery vehicles to launch foreign firms' spacecraft, joint development of spacecraft, and so on. Third, it is necessary to ensure widespread introduction of the achievements by missile-space technology in the national economy. Only the implementation of these points could give us confidence that our civic stance, our civic duty to the country and the world community will not be breached. Specific deeds are needed.

[Rebrov] Vladimir Fedorovich, here we are back to general political problems. Being the general designer and leader of a large production association, you are at the same time a member of the USSR Academy of Sciences Presidium and a people's deputy to the country's supreme organ. Your views on perestroyka?

[Utkin] I am in favor of pluralism of opinions right up to multiparty system subject to observance of a rule-of-law state's laws. One often hears it asked today: "Who is to blame?" As a Communist who was admitted to the party on the frontline during the harsh years of the Great Patriotic War, I can say this: The only right we had [at that time] was to be the first to rush into attack; people paid for the Fatherland's freedom and independence with their own lives. Why blame them? But as a Communist of 46 years' standing, I cannot evade my own share of responsibility for the fate of the CPSU and its role in society.

[Rebrov] How about your practical participation in the USSR Supreme Soviet's work and your appraisal of what is happening?

[Utkin] I am on the Committee for Defense and State Security Questions. Numerous questions have to be resolved. I think that it is necessary to achieve the adoption of the Law on Planning and on Ensuring Conversion on a Statewide Level, at Local Level, and at Enterprise Level, and on assistance for working people who might lose their jobs as a consequence of conversion. Care must be shown for people's future.

What worries me as deputy and as general designer? Many people perceive disarmament as "zero arms,"

forgetting that reality is such that we must think of the state's protection. This task will remain with us for a long time to come. I am also worried about the Union's future. Our defense system is multinational. The scientific potential, including the defense sphere, is also multinational. Unique technical systems and technologies have been developed through the republics' cooperation. The Union's destruction will not only inflict tremendous losses in culture but will also have an effect on the country's production potential and on science. Major work cannot be done single-handed.

[Rebrov] A few words about perestroyka in science? Numerous problems have accumulated there as well.

[Utkin] I would like to dwell on two aspects. First, the reorganization of our missile-space science. Now it is built on the principle of fundamental scientific research at academic and education establishments, sectorial science in sectorial scientific research institutes, and experimental-applied science at industrial enterprises. Over the decades of solving applied tasks, the industrial enterprises' scientific collectives have gained strong positions and their scientific potential is superior to that of sectorial institutes. But sectorial institutes are the arbiters of fashion because they are at the summit of the administrative-ministerial pyramid and hold the purse strings....

I therefore fully support the proposal by some of our scientists that it is necessary to revert to the classical structure of science (as it is done in the developed capitalist countries): Academic scientific research institutes and higher education establishments should develop fundamental science, while experimental-applied science should be developed at science and production association, production associations, and sectorial scientific research institutes. The tasks of controlling functions by scientific research institutes should be reviewed during the implementation of reform in missile-space science. Quite a powerful scientific potential has been concentrated there, but the efficiency of its utilization could be considerably greater if their controlling functions were reduced.

And one more point. I believe that our long-term program for the development of missile-space technology must be profoundly reworked from the viewpoint of both priority avenues and economic effect.

[Rebrov] What do you think, has your civic stand undergone hard trials in the recent past?

[Utkin] I recently visited Cuba as member of a USSR Supreme Soviet delegation. I recalled 1962, the Caribbean crisis, and the role played by our missiles in it. That was 28 years ago. And the Cubans are once more saying: We rely on you, don't let us down. There is some food for thought. How to help the Cuban comrades, and not just them? Attitudes toward our friends represent a special facet of the "philosopher's stone." Shall we concentrate only on ourselves, on our own personal problems? Or shall we seek a way out of the present crisis not only for ourselves but also for our friends with due consideration for the world community? After all, the path we take will determine the future not only of our country but also of the planet.

[Rebrov] The press recently carried a report about the Soviet Union's intention to present an "SS-4" missile to one of Cuba's museums. This caused alarm in the United States. Some foreign figures assume that it could be fitted with a warhead.

[Utkin] Such opinions are a joke. Obviously, the old thinking still holds sway with some people.

[Rebrov] Vladimir Fedorovich, we were taught for a long time that the work of chief and general designers always runs smoothly, and each TASS report includes the standard sentence "All systems are functioning normally." Is this really so?

[Utkin] Not quite so, in fact not at all so. There have been failures, mistakes, and accidents, there have also been "black days" when human lives were lost. I experience pain and grief on 24 October each year. It was on that day in 1960 that an explosion occurred on the launch pad while an ICBM we had developed was being prepared for its first launch. That was when Marshal Nedelin and other comrades were killed. Parity had to be paid for with human lives....

But one ought not to think that wreckage and failure pursue us each day and each year. Before a complex is submitted to the State Commission, it goes through numerous stages of "in-house" trials. They are the general designer's responsibility. This is probably why my comrades, colleagues, and friends lost their lives so early.

[Rebrov] And one last question. I recall your statement about the "philosopher's stone of disarmament" which, once accepted by us, will enable us to preserve our home, society, and planet. Should we forget about the sufficiency of our defense when elaborating proposals on foreign peace initiatives?

[Utkin] No, of course not. But let us add the qualifier "reasonable" to the word "sufficiency."

[Rebrov] I agree. Thank you for the frank conversation.

[Utkin] I thank you, too; I am one of your readers.

Details of Voskhod-2 Flight Recounted

907Q0061 Moscow SOVETSKAYA ROSSIYA in Russian 17 Mar 90 p 6

[Article consists of excerpts published in SOVETSKAYA ROSSIYA from the diary of Col.-Gen. Nikolay Petrovich Kamanin, under the rubric "Pages from a Diary": "He Soared Freely Above the Earth: On the 25th Anniversary of the Flight of Pilot-Cosmonauts P. I. Belyayev and A. A. Leonov in the Voskhod-2 and the First Spacewalk"; first three paragraphs are source introduction]

[Text] **The readers of SOVETSKAYA ROSSIYA have already had occasion to familiarize themselves with the diary excerpts of N. P. Kamanin, colonel-general of aviation. One of the famed aviators of our country whose name was widely known even before the war, he devoted a great deal of effort to the creation of the Soviet space program.**

Today we are publishing pages from the diary of Nikolay Petrovich Kamanin which tell of the flight preparations and the flight itself of the Voskhod-2 space vehicle, during which Pilot-Cosmonaut A. A. Leonov was the first in the world to walk in open space. A quarter of a century has passed, and in reading now the diary entries made by Kamanin about the heated aftermath of the event, one gets a particularly good idea of how complicated and difficult each new step in the conquest of outer space was.

The article was prepared by the son of N. P. Kamanin—L. N. Kamanin.

13 January

Today I was at the special design office. The meeting, which was attended by about 200, was led by Korolev and Tyulin... The common conclusion of the reports: the boosters and two Voskhod vehicles are basically ready for launch. All the tests could be completed by 15 February. The launch of the unmanned prototype could take place in late January or early February, and the flight of two cosmonauts with one of them walking in space, in March.

The walk in space is a complicated, crucial, dangerous operation. That is why I insisted so strenuously that our flight should take place not in November 1964, as Korolev wanted, but in February-March 1965. It can now be said with confidence that we will successfully carry out this flight in March. Of course, it is still necessary to "squeeze" the industry people and get a backup of the oxygen supply to the cosmonaut for the spacewalk, since we cannot trust 100 percent in the self-contained oxygen device.

The upcoming experiment will be our greatest achievement in the conquest of outer space since the flight of Gagarin. Aleksey Leonov and Yevgeniy Khrunov (the latter is part of the backup crew) have been trained for the first spacewalk. Both of them are excellent cosmonauts, and, moreover, Leonov is an artist. He will surely be the best one to feel the uniqueness and beauty of this experiment and will be able to convey his feelings and observations after returning to Earth.

15 January

Cosmonauts Belyayev and Leonov are going through tests in the centrifuge. So far, the doctors have found nothing wrong with Leonov, but there have been unfavorable signals for Belyayev—he is already 40 years old, and his health is somewhat weakened. I am not entirely confident that he will pass all the stages of the training. Therefore, besides including cosmonaut Zaikin in the training, I have ordered that Khrunov be prepared to be a backup not only for the spacewalk, but also for the role of crew commander. The Khrunov-Leonov team is surely stronger than the Belyayev-Leonov team, but since the role of the space-walk pilot is especially important in the upcoming flight, we have been training our strongest cosmonauts—Leonov and Khrunov—primarily for the spacewalk. We are now also providing them with training for the role of crew commander.

3 February

The flights aboard the Tu-104 with simulation of a spacewalk in conditions of weightlessness and several special training sessions for the cosmonauts in the TBK-60 thermal altitude chamber have demonstrated the full complexity and danger of the upcoming spaceflight. It will undoubtedly be a very difficult flight, but it should also throw open the doors of space to us. Walking on the surface of the moon and the planets will become more feasible, and the docking of vehicles in orbit and the assembly of orbital station structures will not require intricate automation—in large measure, those operations could be entrusted to the cosmonauts. The success of this flight will elevate immeasurably the role of the human factor in carrying out space research, and it will demonstrate that the human being is the most sophisticated "machine" both on Earth and in space.

5 February

This week, the main crew and the backup crew of Voskhod-2 are training in the altitude chamber. On 8 February, Belyayev and Leonov are scheduled to make an "ascent" to an altitude of 37 kilometers. After the flights in the Tu-104 in conditions of weightlessness, the training in the TBK-60 is both the most difficult and the most necessary. The conditions attending most of the training sessions for the cosmonauts on Earth and in the air are much more difficult than those which they will have to endure in spaceflight—this we know for a fact. But, primarily, we have no other means of training thus far; and, second, we are training the cosmonauts on the basis of the principle of "hard in training, easy in battle."

19 February

The launching of the unmanned prototype craft is tentatively set for 21-22 February, and the flight of Voskhod-2 with crew for 4-5 March. The manned flight program will be adjusted on the basis of the results of the launch of the craft carrying the mannequins.

We have been preparing for this flight for almost a year. The designers and the workers, the scientists and the cosmonauts—they all have worked together to develop what is needed for the first walk in outer space. A new space suit has been created, an air lock has been designed, new life support systems have been developed, and dozens of improvements have been introduced into the craft's control systems and its assemblies. Hundreds of studies, tests, and training sessions have been carried out. Much has been envisaged, studied, and experimentally verified, but in terrestrial conditions it is not

possible to take absolutely everything into account—there may be some surprises.

Therefore, prior to the manned flight of Voskhod-2, we plan to place in orbit three satellites of the Cosmos series, which will send to Earth data on radiation, solar activity, and other cosmic factors.

Today, Korolev, Tyulin, and I reviewed the special modifications to the Voskhod-2 manned flight program. The regular program calls for the cosmonauts to walk in space during the second orbit over the territory of the USSR. After discussing all possible situations, we reached the following decision: the crew will have the option of walking in space during any orbit from the second to the sixth, if for some reason it is not possible to make the walk during the second orbit.

22 February

The launching of the Voskhod-2 unmanned prototype took place at 12:30 local time and passed without event—the flight began successfully.

We were most doubtful that the air lock would function reliably, but our doubts were not borne out: the charging of the air lock and its sealing, the opening and closing of the hatch, the filling of the lock with air—all went well. During the first orbit, the craft was observed by special television circuit at Simferopol and Moscow. We also gathered around the television set, though not really expecting to catch a glimpse of the craft, since during the first orbit it was quite far from the proving grounds. Quite unexpectedly, a distinct image of the front part of the air lock appeared on the screen, causing an outburst of joy among all present...

Kerimov, myself, and Pravetskiy were placed in charge of the flight control operations groups. My shift was supposed to go on duty at 16:00 Moscow time, and so I went to dinner and relaxed a little. Korolev and Tyulin followed my example, leaving General Kerimov in charge of the control facility... When I returned two hours later to the control facility, Korolev, Tyulin, and Pravetskiy were already there. All three were visibly shaken. To my greeting of "Good evening!" Korolev responded, "No, Nikolay Petrovich, the evening, it seems, is not good. It looks like the craft has blown up..."

In order to determine the causes of what had happened, a commission was created under the direction of Kerimov (at my recommendation, Col. Komarov from the air force was included among the members of the commission). Based on an analysis of the nature of the accident, on reports from the measurement stations, and on examination of the flight path, the commission came to the conclusion that the reentry cycle had been spontaneously initiated in Voskhod-2, the braking engine had been triggered, but the craft had not descended from orbit, instead only modifying the orbit, and within several minutes after cutout of the braking engine it was exploded on command from the automatic self-destruct system. It only remained to determine where the command to descend came from: was it the result of a malfunction aboard the craft, or was it received from Earth? If the charges against the craft are dropped and it turns out that Ground Control is guilty, it will be possible to prepare Voskhod-2 for the manned flight within the appointed deadline—otherwise, the flight will have to be postponed for an indefinite period of time.

24 February

From conversations with Tyulin, Kerimov, and many specialists, I have become firmly convinced that the craft and its equipment are "not guilty" in the matter and that if there had been a pilot aboard Voskhod-2, the accident would not have happened, and we would have obtained valuable flight data. A year ago, during the first discussion of the idea of Voskhod-2, I proposed performing the first launch of the craft not with mannequins, but with a man, though not with a spacewalk. At the time, Korolev did not agree with my proposal. He was troubled not by technical considerations, but by purely political considerations—a one-day test flight with one cosmonaut would not represent a new triumph in space. In the opinion of many, each manned spaceflight should be a new, major advance. That opinion is wrong. Major accomplishments in space must be prepared by manned "preliminary" flights to check out the equipment and train the cosmonauts. With a man on board the spacecraft, we would achieve new successes more quickly. But if you're going to do that, you can't go up into space for ballyhoo and national parades—you have to go up in deliberate conquest.

And so, the manned flight of Voskhod-2 is moved to the second half of March...

25 February

At an expanded meeting of the accident commission, Chief Designer Mnatsakanyan and Col. Bolshoy gave reports. The first proved convincingly that the cause of the accident was the operation of measurement points IP-6 and IP-7. Film obtained from IP-7 pinpointed the time of formation of the command for descent and the acknowledgment confirming receipt of that command for execution by the unmanned craft. Furthermore, laboratory investigations were carried out in Moscow as to the possibility of the formation of a command to descend when two measurement points are working with the craft at the same time. It turns out that two simultaneously transmitted No. 42 commands ("Transfer air to air lock") may be perceived by the craft as one No. 5 command ("Descend")... It became clear from Col. Bolshoy's report that General Karas took no special measures to prevent the measurement points from working in concert, merely issuing the customary instruction that IP-6 was the main station, and IP-7 the backup, i.e., it could send commands to the craft only upon further orders from Moscow. The commander of IP-7 violated this instruction and sent a command at a time when he was supposed to "keep quiet."

Thus, the spacecraft has been fully exonerated.

26 February

At midday, Korolev called and asked me and General Kholodkov to come over. Sergey Pavlovich apologized for receiving us while he was in bed—the doctors said he has a focal pulmonary inflammation and gave him strict orders to stay in bed. He is already getting better—today his temperature did not rise above 37, whereas two days ago it was 39. We are convinced that Korolev "doesn't know how" to be sick—the telephone rang continually, greatly interfering with our conversation. Korolev, like ourselves, was worried about the safety of Voskhod-2 descending with the base ring of the air lock, which had not been verified in spaceflight conditions... Korolev decided to verify the reliability of the descent with the ring with the unmanned Zenit. We approved of his decision and promised to firmly insist upon it at the state commission.

Our conversation then took a new direction. Turning to me, Korolev, who had already expressed his displeasure with the air force physicians and specialists, said that he was not pleased by an article in the journal AVIATSIYA I KOSMONAVTIKA, calling for more stringent standards for cosmonaut candidates. I did not want to upset the patient or weary him with long discussion, but I could not hold back and said: "Sergey Pavlovich! For a single flight into space, old folks like you and I could be sent up, but for the profession of cosmonaut, we need only absolutely healthy individuals." Korolev was displeased with my rebuff, but was not about to argue and said, in a conciliatory gesture: "Well, perhaps, for work in space you military people really do need only Gagarins..."

We also talked about our prospects. In discussing them, Korolev kept on repeating the same thought: the air force could do much more for the conquest of space than it was doing at present...

9 March

At the second pad, a meeting was held under the direction of Tyulin, concerning the makeup of the crew for Voskhod-2. Korolev asked for a comparative evaluation of each candidate. I told the meeting that, in terms of all flight training results and in terms of state of health and general development, the four candidates go like this: Leonov, Khrunov, Belyayev, and Zaikin. But since Belyayev and Leonov have already been training together for more than half a year, it is not advisable to separate their "duet," and Khrunov should be appointed to back up Leonov or Belyayev. Severin, who was at the meeting, said that Khrunov, in his opinion, was a stronger cosmonaut than Belyayev. It seemed that Korolev, Tyulin, and Pravetskiy also had doubts about the candidacy of Belyayev, but none of them said so directly. After all representatives of the military firmly declared in favor of Belyayev, Korolev said he had no further questions for discussion. We resolved: "The meeting confirms the previous decision regarding the makeup of the crews: main crew, Belyayev and Leonov; backup crew, Zaikin and Khrunov."

10 March

A final decision has been made: on the day of the flight, only three—Belyayev, Leonov, and Khrunov—are to suit up in spacesuits. We have no desire to send Zaikin into space, and so the only actual backup will be Khrunov, who is trained to replace both the pilot who will walk in space (Leonov) and the crew commander (Belyayev).

I chatted with Belyayev and Leonov. I told them of the last decision of the leaders of the state commission as to the makeup of the crew and the doubts about Belyayev. These doubts surfaced two months ago, when Col. Karpov reported that Belyayev had a poor showing in the altitude chamber tests. I told Karpov at the time not to be hasty, but to look carefully into this matter. Two days later, Gen. Babiychuk reported that there had been a malfunction in the recording of the telemetry data during the course of the testing and that Belyayev's health was not in question.

Today, Leonov told me the following about what had happened. During the training session, Belyayev began to gasp for breath because oxygen was not coming into the altitude chamber. But he displayed admirable composure, found the problem, and corrected it. Those responsible for the malfunction were the factory specialists supporting the experiment, but Belyayev did not "tell" on them and took all the responsibility for what had happened.

13 March

In the morning, I took part in the Korolev-led review classes with the cosmonauts. We discussed the matter of UHF and HF communications between the crew and Earth, and we clarified the procedure for the cosmonauts to report on the progress of the flight and their well-being. Summing up the classes, Korolev said:

"I have no doubt that you know the craft, its equipment, and all the spacewalk operations better than I do. Our conversation was useful to everyone, and especially to me: not only have I become convinced of your readiness for the flight, but also I myself now know more and feel more confident. I want to warn you once more that the most important thing in your flight is to return to Earth healthy. We do not need thoughtless heroics. Of course, it is very desirable that you accomplish the full scope of the 'Spacewalk' program, but you must always remain calm and take no unnecessary risk. I wish you success, comrades! I am sure that you will accomplish the mission..."

14 March

Today was a day off for everyone, but the cosmonauts underwent medical examination in the morning, and

after that it was necessary to hand them over to the film crew for a long time. After the midday meal, the gang relaxed, playing volleyball, chess, pool.

Journalists Denisov, Romanov, Melnikov, Peskov, and Mikhaylov—all old acquaintances of mine—have come to the proving grounds. Tomorrow they will hold a prelaunch press conference with the cosmonauts. Also tomorrow is the touchdown of Zenit, which was put into orbit on 7 March. It will either bring us even more confidence in the success of the upcoming flight or strengthen our misgivings.

15 March

Zenit touched down safely 170 kilometers to the south of Kustanay. The parachutes worked normally, and it can be assumed that there was no major spinning caused by the protruding base of the air lock chamber during the landing of Zenit. Tomorrow, after analysis of the film with the recording of the flight parameters, we will know the exact speed of rotation of the craft during the its reentry. We hope that tomorrow will not delay the flight of Voskhod-2.

16 March

A week has already passed since the cosmonauts arrived at the proving grounds. It has been cold and windy the whole time, except for today, which was a wonderful, quiet, sunny day...

At 11:00, the meeting of the state commission began. For forty minutes Korolev reported the progress in the development and testing of all systems of the Voskhod-2 craft. The state commission resolved: "On 17 March, in the morning, the rocket and Voskhod-2 craft will be taken to the launch pad, and a launch will be carried out on 18 or 19 March (whenever ready)."

At 16:00, the customary meeting of the state commission was held to approve the makeup of the crew for the spaceflight. On behalf of the air force, I moved that Lt. Col. Belyayev be confirmed as crew commander, and Maj. Leonov as the pilot-cosmonaut performing the walk in space. The backup crew was confirmed, and it consisted of Maj. Zaikin, crew commander, and Maj. Khrunov, cosmonaut performing the spacewalk...

Thus, all preparations for the flight of Voskhod-2 are basically complete. There remains the very difficult and dangerous flight itself, but we have done a great deal for its success, and I am confident that we shall succeed!

18 March

Twelve midnight... I am at the control facility, in charge of the Voskhod-2 spaceflight. It is now quiet here, and we have no communications with the spacecraft: it will not pass over the USSR from the seventh through the thirteenth orbit.

Today has been a hectic, unforgettable day. For the first time in history, a man walked in outer space; the walk was performed by Soviet citizen Aleksey Arkhipovich Leonov. We watched him on television as he soared fluidly in space against the backdrop of the Earth. He waved to us with his left hand, then with his right, and then he turned around several times in free flight, moving 4-5 meters away from the craft. I had been confident that the "Spacewalk" operation would be successful, but, to be truthful, I did not expect such a total triumph.

The crew had arrived at the launch pad at 9:20. Leonov was visibly excited just before he got into the craft; Belyayev, as always, appeared to be completely unperturbed. Korolev, Kamilov, Shabarov, Gagarin, and I remained at the rocket until the 10-minute warning, and then we moved to the bunker. The launch went off splendidly, although the first 40 seconds of the flight kept us in fearful suspense (in event of an accident prior to the fortieth second, it is almost impossible to save the crew). And in fact, all the other countdowns before the craft was placed in orbit were full of alarm—even the nonsmoker Korolev, after the count of 530 [seconds], crumpled a cigarette with his stiff fingers and lit up...

The most dangerous ordeals are now behind us. True, we are a bit troubled by the elevated (around 45 percent) content of oxygen in the cabin, as well as the rotation of the craft at a rate of 20° per second, which is several times greater than it is supposed to be. The rotation of the craft can be slowed down, but after consulting with the crew, we decided to do that just before landing—the working fluid of the stabilization engines needs to be conserved. The flight is not yet over, but its main mission has already been performed splendidly. The landing of the spacecraft is another difficult matter, but we have already done it dozens of times, and so it should not worry us as much as did every step Leonov took in open space.

19 March

I left the control facility and went to relax in the cosmonaut dormitory at three o'clock in the morning, local time, but at seven I was roused by an "urgent" telephone call. When I returned to the control facility, Korolev was already there. He gave me an unpleasant bit of news: in the last (thirteenth) orbit, the pressure in the cabin pressurization tanks of the craft had dropped from 75 to 25 atmospheres. A further drop in pressure could lead to complete depressurization of the craft and a forced landing...

After careful analysis of the situation, we came to the conclusion that there was evidently no great cause for alarm—the supply of air and oxygen aboard the craft should hold out until the seventeenth orbit, when the regular reentry was planned. Chief Designer Voronin firmly stated that the pressure in the craft's cabin could not fall below 500 millimeters, in which case there would be more than enough oxygen for three hours. In the fourteenth orbit, we established communications with the crew. Belyayev reported that the pressure in the

pressurization tanks had stabilized at a level of 25 atmospheres, that the other parameters of the cabin were normal, and that the crew felt fine. A decision was made to perform an automatic landing during the seventeenth orbit of the mission.

The first command of the landing sequence went normally. We impatiently awaited information as to the progress of reentry, but the reentry did not take place: the automatic attitude control had not kicked in and the braking engine had not fired—which meant the craft was still in orbit. We decided to land the craft manually (the first time in our experience!) during the eighteenth or twenty-second orbit. A second round of wearisome waiting began...

We received the first report of the craft's descent rather quickly, from Odessa and Saransk, but we had no reliable information as to the condition of the crew for four long hours. True, the "Krugi" radio stations had located the craft, and Alma-Ata has received a telegraph code several times via HF channel: "VN...VN...VN" (this was a signal from the crew, meaning "Everything normal"). It was nice to have the radio fix and the "VN" signals, but we wanted more convincing data as to the condition of the cosmonauts. Finally, to the joy of everyone, came the long-awaited report of the commander of one of the search helicopters: "On the forest road between the villages of Sorokovaya and Shchuchino, about 30 kilometers southwest of the town of Berezniki, I see the red parachute and the two cosmonauts. There is deep snow all around... The craft touched down in dense woods, far from any population center."

Two hours have already gone by since the helicopter landed 5 kilometers from the touchdown point of Voskhod-2 and disembarked a search team, which is trying to reach the cosmonauts on foot. In addition, two vehicles with soldiers from an air defense regiment are moving toward them. But the way things look, we won't find out about whether the boys have been taken to a population point any time soon. The helicopter dropped them thermal flight clothing (the temperature in the touchdown region is five° below zero), and they have the immense parachute and the descent capsule at their disposal. They won't freeze, of course, but they will long remember this night...

20 March

Belyayev and Leonov spent the night in the woods. The helicopter team, after attempting to reach the cosmonauts during the night, turned back. The group of soldiers from the air defense regiment is also still far from the target area. Early in the morning, a helicopter flew over the landing site of the craft, and the pilot reported: "I see two people near the craft. One is chopping wood, the other is arranging branches in a campfire. Both are wearing the flight clothing."

At 07:30, one-and-a-half kilometers from the crew of Voskhod-2, a group of three individuals headed by Col. Sibiryak disembarked from an Mi-4 helicopter (hovering at one-and-a-half meters), with the mission of reaching the cosmonauts on skis. Soon thereafter, more people disembarked and began to clear an area for the helicopter to land. Sibiryak's group took three hours to cover the one-and-a-half kilometers on skis through deep snow, but even so it was the first to greet Belyayev and Leonov. Physician Tumanov, part of that group, reported: "The cosmonauts are alright, there are no injuries or frostbite."

The cosmonauts could have been evaucated by helicopter this morning. Hovering at a height of 5-6 meters above the ground, the helicopter could have lifted the cosmonauts aboard by rope ladder and deposited them in Perm within a half an hour. In another three or four hours, Belyayev and Leonov could have already been with us at the proving grounds. But Marshall Rudenko gave orders that the cosmonauts were to be evacuated only by motor vehicle. When he was convinced that that was not possible, he gave instructions that they be taken out by helicopter, but only if it landed, and not with it hovering above the ground. Those two ill-advised instructions hampered the initiative of Gen. Kutasin and Col. Sibiryak and ultimately prevented the crew of Voskhod-2 from being delivered to the proving grounds before the day was out.

Thus, 70 kilometers or so from the oblast center, Belyayev and Leonov will spend a second night in the taiga forest. The second night's stay in the woods will not be as difficult for the cosmonauts as was the first (the helicopter dropped them food, tents, and warm clothing). But for the air force rescue service, it represents a major failure. It will be very hard to explain to our people and the foreign community why, after such a brilliant mission, we have kept the cosmonauts in the taiga for two days. I tried to convince Rudenko of the necessity and the safety of lifting the cosmonauts aboard the hovering helicopter by ladder. I was fiercely supported by Korolev, but even his attempts at persuasion were in vain—the marshall told Brezhnev that lifting them in that manner was dangerous, and he repeated his order to the rescue service to prepare a landing site and only then to evacuate the cosmonauts. It was disappointing to see all this overkill approved by the highest level of leadership.

21 March

Even though I did not doubt that Belyayev and Leonov would make it safely through yet another night in the taiga, I did not sleep well. At six in the morning I was already on the phone to Moscow. The air force duty ATC controller reported that the cosmonauts would be taken to Perm by helicopter "relay"—with a transfer from the Mi-4 to an Mi-6... Only at around ten o'clock did the message arrive: "The Mi-6 helicopter with cosmonauts Belyayev and Leonov has landed at the Perm airport"...

At 17:30 we met the cosmonauts at the Tyuratam airport. Everyone chuckled when Belyayev and Leonov

appeared in the doorway of the An-10 airplane, wearing flight uniforms and aviator boots.

22 March

In the morning, the state commission heard the reports of the crew of Voskhod-2. Belyayev talked for 45 minutes, Leonov for more than an hour. Both reports evoked a lively interest in all those present...

After the midday meal, a meeting was held at the second launch pad. The rocket designers, Belyayev, Leonov, myself and Korolev spoke. In the evening, I coached the cosmonauts for their appearances in Red Square and the Great Palace of the Kremlin—tomorrow, early in the morning, we are flying to Moscow.

27 March

The cosmonauts and I have been in Moscow for five days already, but I have not had time to write even a few lines until just now. I will try to reconstruct the most significant events of the past several days.

On the evening of 23 March, there was a government reception in the Great Palace of the Kremlin.

On the morning of 24 March, Belyayev and Leonov, with the help of other cosmonauts and specialists of the Cosmonaut Training Center, prepared their remarks for the press conference. I met them during the day at a meeting with Keldysh in the Academy of Sciences. I had to step forward several times and point out the need to tell the full truth about the flight (the failure of the automatic attitude control, the overshoot of the landing site by 368 kilometers during reentry, and the two nights the cosmonauts were forced to spend in the taiga). Keldysh was categorically opposed to my proposals and demanded that Belyayev write in his report that the spacecraft touched down precisely at the calculated site and that the crew spent two days "resting" in the touchdown region.

On 25 March, at nine o'clock in the morning. I met with Korolev and told him of our dispute with Keldysh the day before. Sergey Pavlovich took my side in this dispute—with me present, he called Keldysh and Smirnov and argued that it was necessary at the upcoming press conference to tell everything about the flight just as it had happened. They resisted for a long time, but after Korolev said that he would talk to Brezhnev on the matter, they agreed to consider our opinion.

The press conference was held on 26 March in the assembly hall of Moscow State University and went well, all things considered. The reports of Keldysh, Belyayev, and Leonov were greeted with great interest. Leonov responded to the questions much better than did Belyayev and Keldysh. Many answers to the questions did not please me—there was still an attempt to conceal what it was pointless for us to hide.

21 April

Belyayev and Leonov completed a weeklong examination at the aviation hospital. Today, straight from the hospital, they came to me and reported that the doctors found no abnormalities in their health. At the time of their arrival, I was talking with one of the new cosmonaut candidates, aviator Bredikhin. I must say, we are very particular about each candidate. We try to understand the motives prompting him to seek a career in space, we explain that the conquest of outer space is a difficult and dangerous job, we "scare" him with 80° heat [Celsius], large g-forces, the lengthy solitude in an enclosed space, and the possibility of serious mishaps. I asked Belyayev and Leonov to tell the young aviator the truth about all the hardships of the profession of cosmonaut. Belyayev, turning to Bredikhin, said: "You are deeply mistaken if you judge space only from the newspaper accounts and the triumphal receptions of the cosmonauts. When you are going through the commissions, look more closely at the conditions of our work, and you will see that the rose of space has not only a pleasant aroma, but also sharp thorns..."

I just glanced through the notebooks with my diary entries. It was necessary to make them in snatches, often breaking off in midsentence, and not being particularly careful about style. But many of the facts and events of which I write are so intriguing in themselves that I do not think they need an "artistic presentation." I don't know if my diaries will ever be of interest to the public, but for me they are not just personal notes: as far as I am concerned, I have not performed my professional and moral duty unless I write down the main facts about the first steps of the Soviet space program.

IKI Director Outlines Essential Space Science Missions

907Q0149A Moscow PRAVDA in Russian
17 Aug 90 First Edition p 3

[Article by A. Galeyev, corresponding member of the USSR Academy of Sciences and director of the USSR Academy of Sciences Institute of Space Research: "There Is No Benefit in Argument: Prospects for the Development of Soviet Space Research"]

[Text] No matter how heated we may become, when arguing we must rely on specific knowledge about the subject of the dispute. There have recently been a number of critical attacks on space research: Spending is too high and the returns too low. Particular complaints have been directed at the proportion of fundamental research in space. Now, they say, that is the least of our worries. And what are Soviet plans in this regard?

Unfortunately, the public's ideas about spending on scientific space research and its supposed insignificant contribution to solving urgent questions of scientific and technical progress are far from the reality. Only two or

three percent of all allocations for space research in the Soviet Union are used for research in the interests of basic science.

Meanwhile it is fundamental science in particular, as it is called, that creates the foundation for the applied disciplines. And it is through fundamental science that they become a production force. All the most important sectors of today's technologies—electronics, nuclear power engineering, computers—have their origins in fundamental science. True, possible practical solutions are not always seen, particularly during the initial stages of research, but the results often go beyond even the boldest expectations.

And so activity in space should remain an integral part of our lives all the time and should be continued from day to day and from year to year. It cannot be regarded as a series of conjunctural leaps, each of which requires a massive concentration of effort.

Over the next decade the Soviet Union plans to send astrophysics laboratories into space which will make it possible to see all parts of the electromagnetic spectrum from gamma quanta to radio waves. As a result we may expect the detection and detailed study of planetary systems around other stars; to obtain data on the origin and development of life in the universe; reveal the mechanism involved in physical processes under the extreme conditions in neutron stars and black holes; and achieve radical advances in research into the properties of space and time, electromagnetic particles, and the evolution of the universe.

One of the most important sources of new information will undoubtedly be the Spektr-Rentgen-Gamma orbiting observatory, scheduled for launch in 1993. The sensitivity of the main telescopes on the observatory in the standard x-ray range is a thousand times better than the sensitivity of the apparatus that is operating today aboard the Kvant module.

Another project is the Spektr-UFT astrophysics observatory for a variety of spectral and photometric observations that will be superior to all space programs up to now devoted to studies in the ultraviolet.

The development of a ground-space system made up of an orbiting radiotelescope and a ground network of the largest telescopes in the world is planned to study the radio range. In terms of its resolution, this system will be the equivalent of a gigantic radiotelescope with an antenna tens of thousands of kilometers in diameter.

Finally, another two key projects in the long-term program of astrophysics research will enable us to look at the very beginning of the existence of the universe. What we are talking about here is conducting cosmological and astrophysics studies in the still virtually unstudied submillimeter range—the Spektr-IK project—and also the continuation of the so-called primal radiation in the millimeter range. This radiation is what is left from very ancient epochs and it makes it possible to assess the state of the universe many billions of years ago.

With regard to studies of the solar system, experience has shown that the most effective as far as scientific yield is concerned is a consistent program comprising a number of missions to one object at intervals of several years. Here each preceding expedition creates a basis for new and more complex missions. This is what has been done with the Moon and Venus. Now it is planned to implement a similar program for Mars.

Why, after this relatively long interval, has Mars become a "first magnitude star" in the sky of space research? Interpretation of the data obtained from apparatus aboard space vehicles has significantly extended the ideas about that planet, but many questions concerning its nature remain unresolved or require further study. At the same time, in these years new ideas have emerged about some of the facilities used to study Mars. What I have in mind is the use of aerostat probes to study the dynamics of the atmosphere, the mineralogical mapping of its surface, and taking infrared heat pictures and studying the vertical structure of the atmosphere from spectral measures of solar radiation under solar eclipse conditions on Mars.

The first stage of this research program for Mars is planned for 1994. It is planned to conduct global studies of its surface and atmosphere with the help of artificial satellites, aerostat probes dropped into the atmosphere, and meteorological stations sent to the Martian surface.

In 1996 it is planned to continue the study of Mars and bring back to earth rock samples from its moon Phobos. And two years later a self-propelled apparatus—a "Marsokhod"—should start to operate on the surface of Mars equipped with drilling gear. And during the next century it is planned to bring back to earth samples of Martian rock and to develop the means for a manned Martian expedition.

The "Tsiolkovskiy" project is to occupy an important place in the broad program of solar studies planned. It will include the development of a special probe and its insertion into a trajectory that takes it toward the Sun using the gravitational pull of Jupiter. This will provide an opportunity to take measurements in the inner part of the heliosphere—virtually the only area of the solar system that remains unexplored.

The experts have no doubts about the need to conduct solar studies at close range. This kind of work is going on both at NASA in the United States and within the European Space Agency. It is clear that missions to the only star accessible to us should be consistent and should combine the efforts of many countries. A single probe will not suffice here: A first expedition could produce totally unexpected results.

Experimental studies of space plasma are closely associated with studies of the Sun and solar-terrestrial links.

Today it is quite obvious that the solar wind and the earth's magnetosphere and ionosphere are closely interlinked and constitute an electrodynamic system that is extremely variable over time. Accordingly, studies of the cause-and-effect links between the phenomena that play within this system require simultaneous monitoring of different critical fields in each of its elements using several space vehicles operating under a single program. Here satellite observations must be "supported" by measures made by ground stations.

We hope to obtain extensive scientific results in the physics of plasma phenomena taking place in circumterrestrial space during the course of the Interbol project. This envisages work under a single program by space vehicles located in space, one of which will be placed at a distance of more than 1 million kilometers from earth.

The development of a sufficiently dense system of satellites would, in addition to answering questions in plasma physics, at the same time be an important element in studies of the effect of solar activity on earth's atmosphere, climate, and biosphere. Solving this problem will become the main goal of studies using a system of small space laboratories equipped with solar sails (the Regata project). The laboratory has been developed right here at the USSR Academy of Sciences Institute of Space Research.

Scientists and experts from many countries in the world are involved in realization of virtually all the scientific research projects planned in our program. This is opening up broad opportunities for developing research equipment at the highest level. Moreover, our partners abroad are making significant financial contributions in the preparations for the projects. In particular, the spending by just the American side in the Spektr-Rentgen-Gamma project will exceed $50 million. In addition to the United States scientific equipment for this laboratory is being developed in Austria, Bulgaria, Great Britain, Hungary, the GDR, Canada, Italy, Denmark, Poland, Portugal, the FRG, Czechoslovakia, and Switzerland as well as by the European Space Agency.

Significant opportunities for cooperation between the USSR and the United States are being opened up in the field of space monitoring of the environment. This year it is planned to launch into orbit a second Almaz space platform—he first was launched in 1987 as Kosmos-1870—with radar equipment. And late in 1991 a Priroda module is to dock with the Mir orbital station. The combination of the Almaz, which possess high spatial resolution and low spectral resolution, and the equipment on the Priroda, which possess high spectral resolution and low spatial resolution, may turn out to be useful for work on the concept of a future regular system used to monitor earth from space.

Successes in space research depend largely on the correct organization of the work. In particular, under the conditions of the funding system existing today for space research, the Academy of Sciences receives money only for direct tasks—the development of scientific apparatus, data processing, and so forth. Funding for rocket technology is traditionally funneled directly to the manufacturers via the Ministry of General Machine Building. In our opinion, effective development of science in space is possible only by allocating all funding to the client—the USSR Academy of Sciences. Under today's conditions we are still subject to the dictates of the producer, and we are being forced to use equipment that does not always satisfy us.

In conclusion I would like to note that the program of scientific studies set forth here for the next 10 years and the prospects for the beginning of the next century is a minimum scenario that will enable the USSR to maintain its present position in the field of space science. It has been drawn up giving due consideration to the space programs of the United States, France, and the European Space Agency. Any curtailment or extension of the periods for completion of the projects will entail serious delays and a decline in the scientific level of scientific research, and will also impair continuity in the projects of various countries. And this in turn will lead to significant financial and political losses.

At this time, however, the Interdepartmental Scientific and Technical Council for Space Research has approved only part of the program proposed by the USSR Academy of Sciences. But it has still not even yet provided guarantees that the necessary funding will be made available.

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DATE FILMED

24 Oct. 1990